New catalysts for the production of biodegradable PHB

Rising concerns over plastic pollution, and tightening regulations like the EU's microplastics restriction, are compelling industries to embrace eco-friendly solutions that reduce waste and the long-term persistence of plastics in the environment. Tomorrow's materials must combine the performance of conventional plastics such as polyolefins with full mechanical and chemical recyclability, as well as biodegradability. The innovative PHB stands out as one of the few materials capable of meeting all these demanding criteria.

IP RIGHTS
EP & US patents pending
2023

Chemical PHB synthesis enables polyolefin-like properties

Until now, industrial efforts have primarily centered on the fermentative production of PHB, due to the lack of an efficient catalyst for chemical synthesis. Our innovative catalysts mark a turning point — enabling a sustainable route for chemical PHB production that significantly outperforms conventional biotechnological methods.

Bruckmoser et al, 2023, JACS

01 PHB as next-generation biodegradable plastic with outstanding performance properties like polyolefins

02 Cost-competitive production like polyolefins due to scalable chemical PHB synthesis from propylene oxide

03 PHB material enabling a circular plastics economy: mechanically & chemically recyclable & biodegradable

	fermentative PHB	chemical PHB (our technology)
Price	6-7 $/kg	3 $/kg
Availability of raw materials	good, but competition with land use for crops	excellent, available on Mt scale (propylene oxide)
Scalability of process	challenging and limited	scalability to Mt scale
Down-stream process / purification of material	costly and difficult (separation of PHB from microbial mass, use of solvents)	no purification necessary
Material properties		
brittleness	highly brittle, additives needed for application	brittleness reduced by a factor of >100; highly ductile, yet hard and tough material
melting temperature	ca. 180°C	ca. 140°C
melt processability	difficult, decomposition occurring	no decomposition occurring due to lowered melting temperature
End-of-life options		
mechanical recycling	difficult, decomposition occurring	yes
chemical recycling	yes	yes
biodegradable	yes	yes

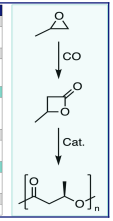


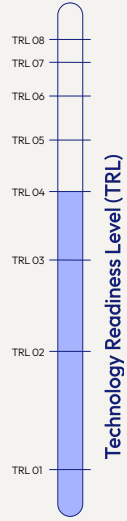
Figure 1: The inventive PHB has strongly improved properties compared to PHB from microbial fermentation.

CHALLENGE

PHB is a biocompatible and biodegradable thermoplastic polyester that can be produced from renewable starting materials, by fermentative and chemical routes. However, pure isotactic PHB as produced by fermentation has a very limited application potential since it is very brittle and difficult to process. Improved material characteristics similar to those of well-established polyolefines such as polypropylene are essential for competitiveness of PHB bioplastics.

INNOVATION

The inventive PHB also lends itself to chemical recycling into the monomers, enabling circular polymer economy approaches. Based on its properties and cost-effectiveness the inventive PHB is ideal for many applications:
- in cosmetics and care formulations e.g. microbeads, texture material
- as thickener or filler in formulations
- as coating material e.g. in agriculture (fertilizer beads, films), in paper industry
- in the packaging industry (clear & dyeable, flexible & rigid)
- as thermoplastic elastomers
- as blend component for performance enhancement of other (bio)plastics (e.g. brittleness reduction)



01 Basic principles observed · **02** Technology concept formulated · **03** Experimental proof of concept · **04** Technology validated in lab · **05** Technology validated in relevant environment · **06** Technology demonstrated in relevant environment · **07** System prototype demonstrated in operational environment · **08** System complete and qualified

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