Fraunhofer UMSICHT

Future of BioPlastics | online event | 10. bis 11. September 2025

Bioplastics in the context of the bioeconomy: A starting point in a complex system – opportunities and challenges

Dr. rer. nat. Mona Duhme

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Pioneering the way to a sustainable world

Fraunhofer UMSICHT

Fraunhofer-Gesellschaft

One of the world's leading organizations for applied research

over

32,000

employees

€ 3.6 billion

financial volume

thereof € 3.1 billion contract research

75

institutes and research facilities

Funding mix

70 % orders

from industry and public sector

30 % base funding

from Germany's federal and state governments

6200

customers from industry

Figures refer to the year 2022: Status as of May 15, 2023

Fraunhofer UMSICHT

Pioneering the way to a sustainable world

2 sites (Oberhausen, Sulzbach-Rosenberg)
Approx. 600 employees
Approx. € 73,3 million total budget

Bioeconomy compact

Perspectives

Multifaceted perspective

- Economic
- Ecological
- Social
- Technical
- Political
- Ethical
- …

Framework

Goal

Attitude

Bioeconomy compact

Perspectives

Bioeconomy and circular economy:

- Concepts
- Originally developed separately
- Now increasingly being considered together

Sustainability and consumption

The most sustainable consumption is that which is not requested.

Bioeconomy compact

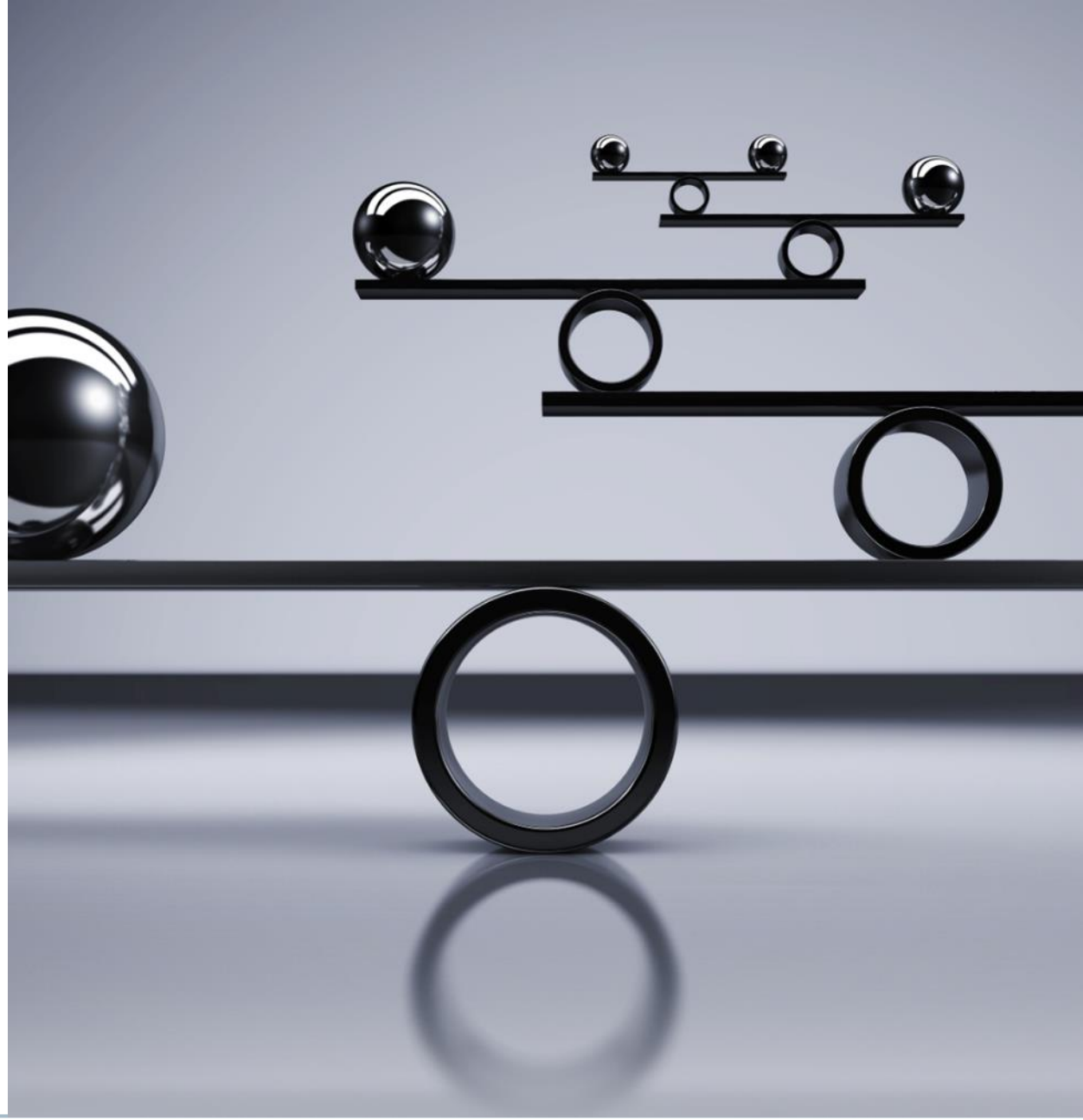
Perspectives

The most sustainable consumption is that which is not requested.

≠

Life means consumption…

but our challenge as scientists is to develop materials that are sustainable and minimize our ecological footprint.



Bioeconomy in the context of plastics products

resource	life cycle assessment	application	regulations	certificates	energy	additives	KPI, USP,…	indepen-dence
reuse	durability	design for recyclability	interaction environment	polymer architecture	rheology	patents	requirements	degradation
repair	quality	lightweight	overdesign	processing	plastic aging	publications	sortability	composting
end of life	bio-based ≠ degradation	costs	chemical safety	product safety	toxicity	practicality	avoidance	…

Design for recycling, durability, reuse, resource

Fraunhofer Cluster of Excellence Circular Plastics Economy CCPE

Project objectives

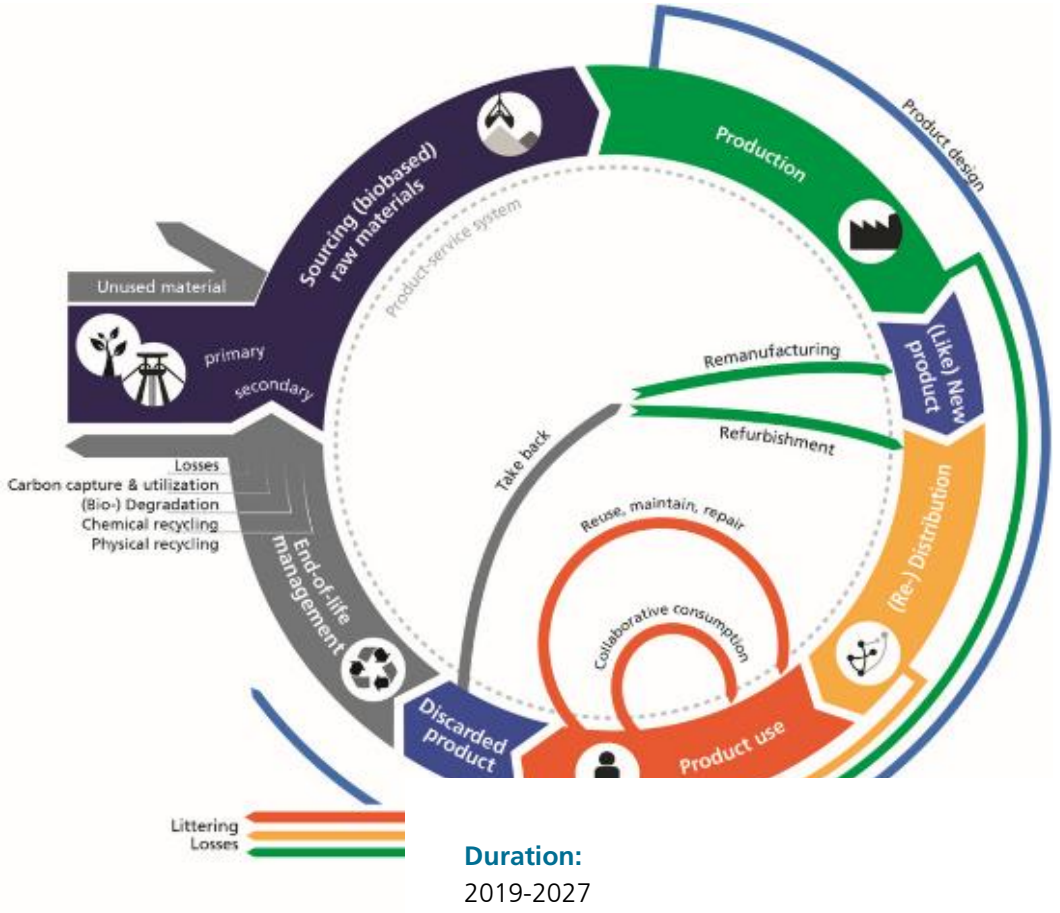
- Promoting the transition to a circular economy in the plastics sector

Procedure

- Circular polymers
- Recyclable additives and compounds
- Advanced recycling
- Circular logistics and sustainability
- Application and demonstration
- Business and transformation

Results

- e. g. **Circular Readiness Level Self-Check (CRL®)** Link



Duration:
2019-2027
Link
https://www.ccpe.fraunhofer.de/

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Life cycle assessment

Ecological comparison of packaging

Project objectives

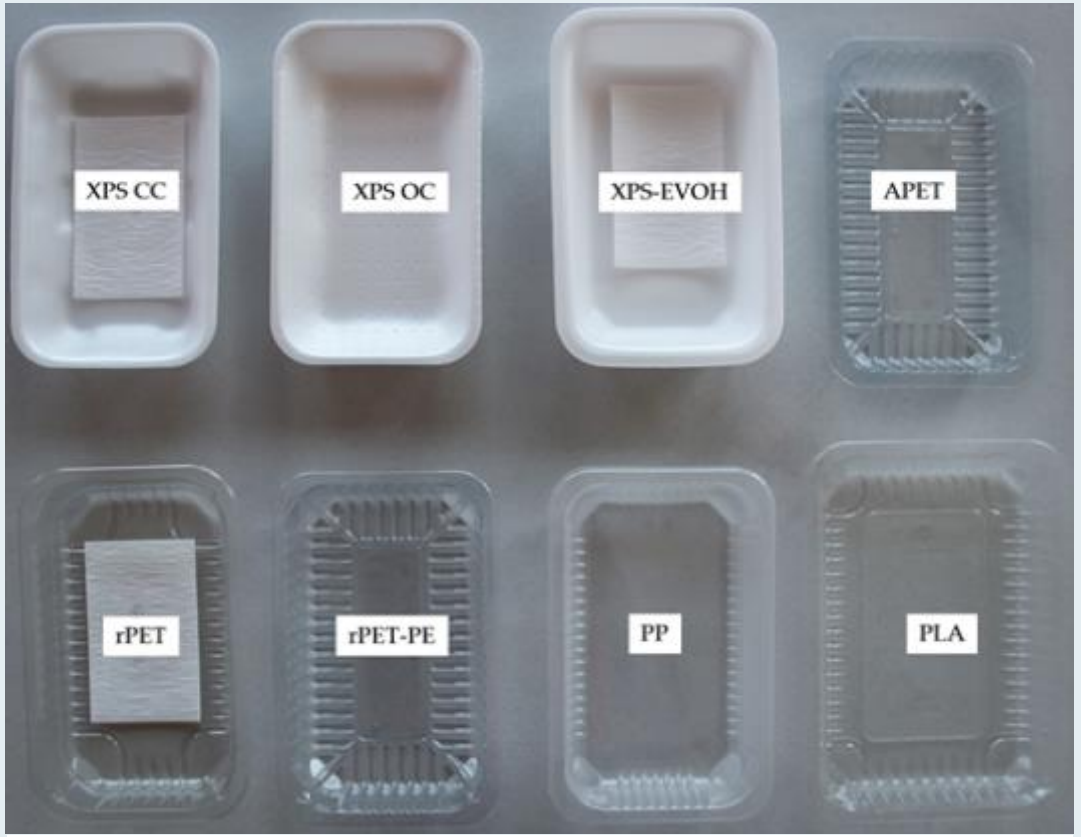
- Ecological assessment of various meat packaging materials made from XPS, PET, recycled PET, PP, and PLA
- Investigation of single-material solutions and multilayer solutions
- Consideration of future recycling rates

Procedure

- Selection and assessment of relevant tray packaging for meat
- Ecological evaluation of alternatives

Results

- XPS trays have the lowest environmental impact, even though they cannot be recycled.



Study from 2019 available online at:

https://www.mdpi.com/2071-1050/11/19/5324

Client:

SIRAP

SILVER PLASTICS

Life cycle assessment

Ecological comparison of packaging

Project objectives

- Life cycle assessment comparison of reusable transport packaging and disposable cardboard packaging in the vegetable segment

Procedure

- Comparative assessment of the life cycle of reusable transport packaging and cardboard packaging

Results

- Per cycle, a reusable transport crate saves 0.38 kg of CO_2 equivalents compared to cardboard packaging.
- Reusable transport packaging also performs better in other environmental impact categories.

Study:

https://ixtenso.de/logistik/oekobilanzstudie-mehrwegtransportverpackungen-schonen-die-umwelt.html

On behalf of ALDI SÜD Dienstleistungs-GmbH & Co. oHG

Bioeconomy in the context of plastics products

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Design for recyclability

PLA-PackGlue | Innovative adhesive for cardboard packaging

Project objectives

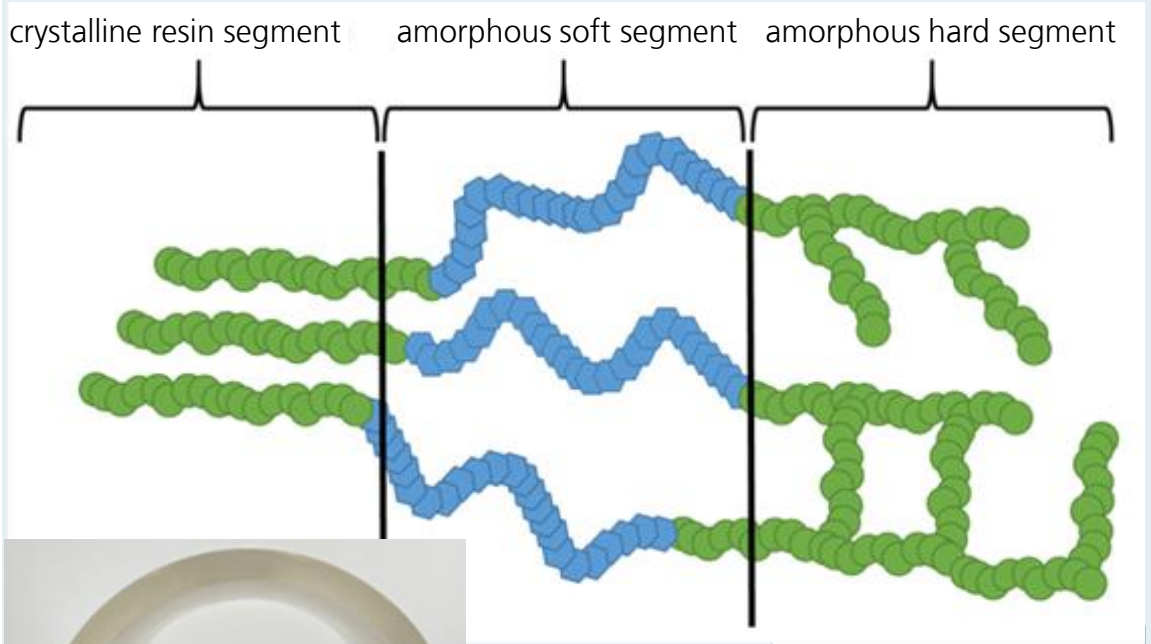
- Bio-based and biodegradable adhesive components
- Applicable like conventional adhesive
- Glueing paper and cardboard with high adhesive and cohesive strength
- Good recyclability in pulp and paper recycling
- Optimized components for an adhesive formulation

Innovation

- Bio-based components and good recyclability in pulp and paper recycling
- Synthesis of polylactic acid (PLA)-based base polymers through targeted design of segment structures

Partners

- Jowat SE, UnaveraChemLab GmbH, BellePapier GmbH, Fraunhofer UMSICHT



Gefördert durch:
Bundesministerium für Ernährung und Landwirtschaft
aufgrund eines Beschlusses des Deutschen Bundestages

Polymer architecture

PhD study L. Marbach | Increasing PLA content in Blends

PLA

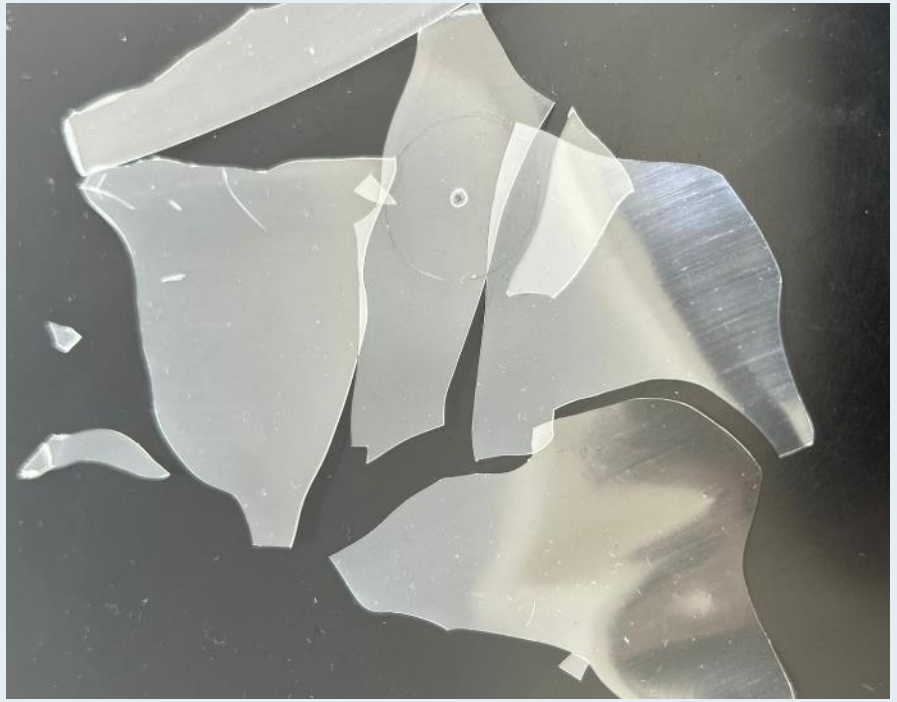
- PLA accounts for over 20.7 % of global bioplastic production
- Mainly packaging sector and consumer goods
- Good mechanical properties (e.g. Young's modulus up to 5,000 MPa)
- Brittleness limits utilization

Procedure

- Blending with state-of-the-art ductile polymers e.g. PBAT (polybutylene adipate terephthalate)

Innovation

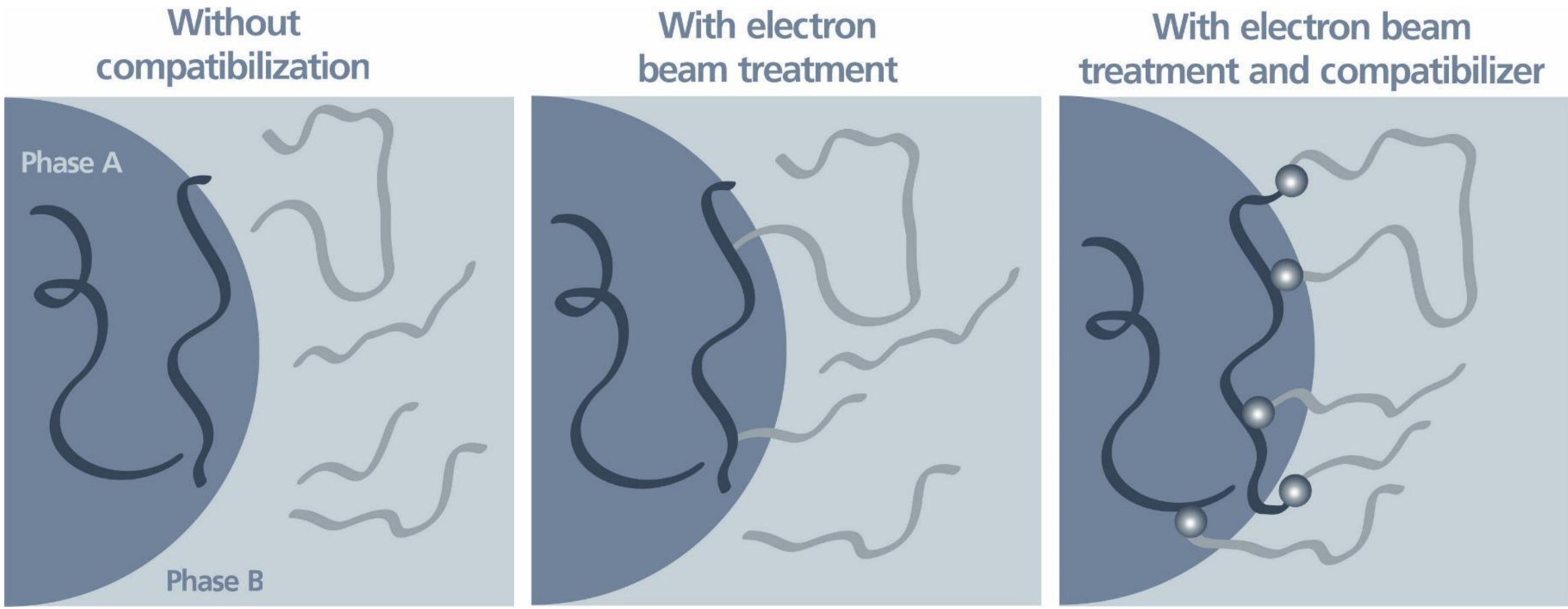
- Epoxidized soybean oil (ESBO) as compatibilizer: Ring-opening reaction with hydroxyl and carboxyl groups of PLA and PBAT
- Electron-beam treatment: Inducing reaction between polymers and compatibilizer



Broken PLA film

Polymer architecture

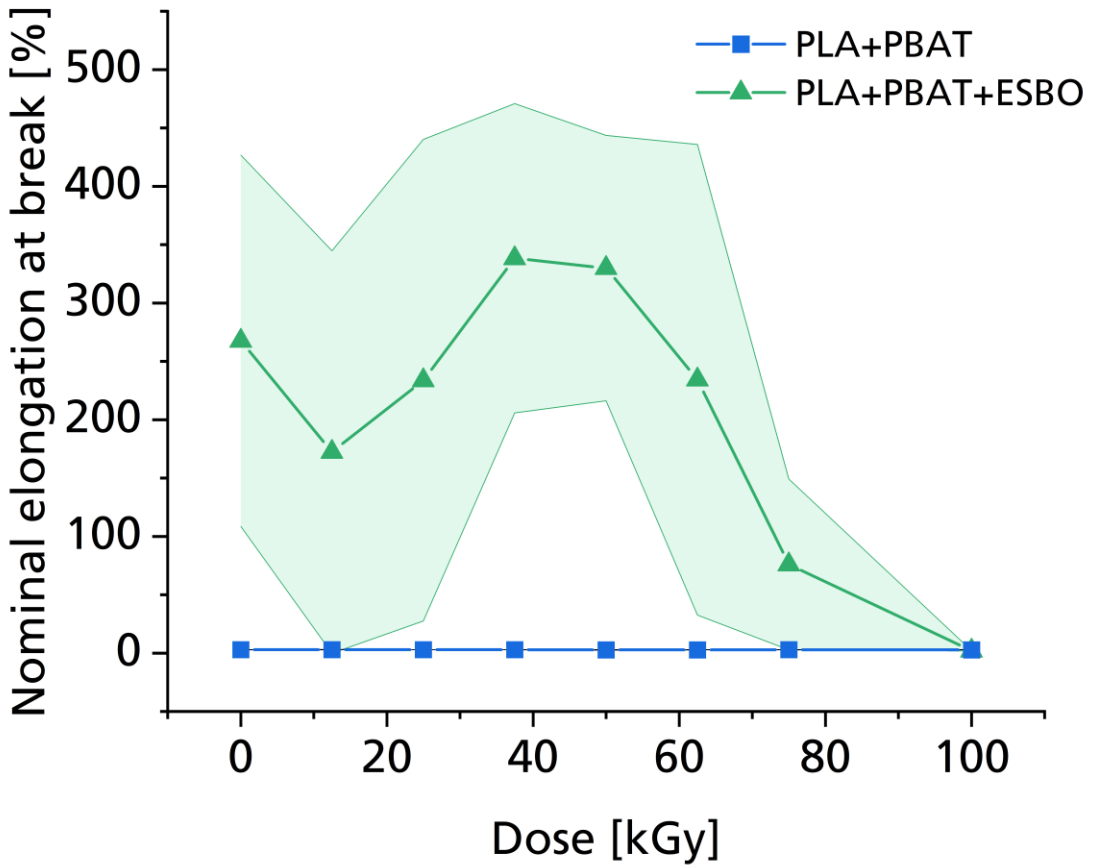
PhD study L. Marbach | Increasing PLA content in Blends



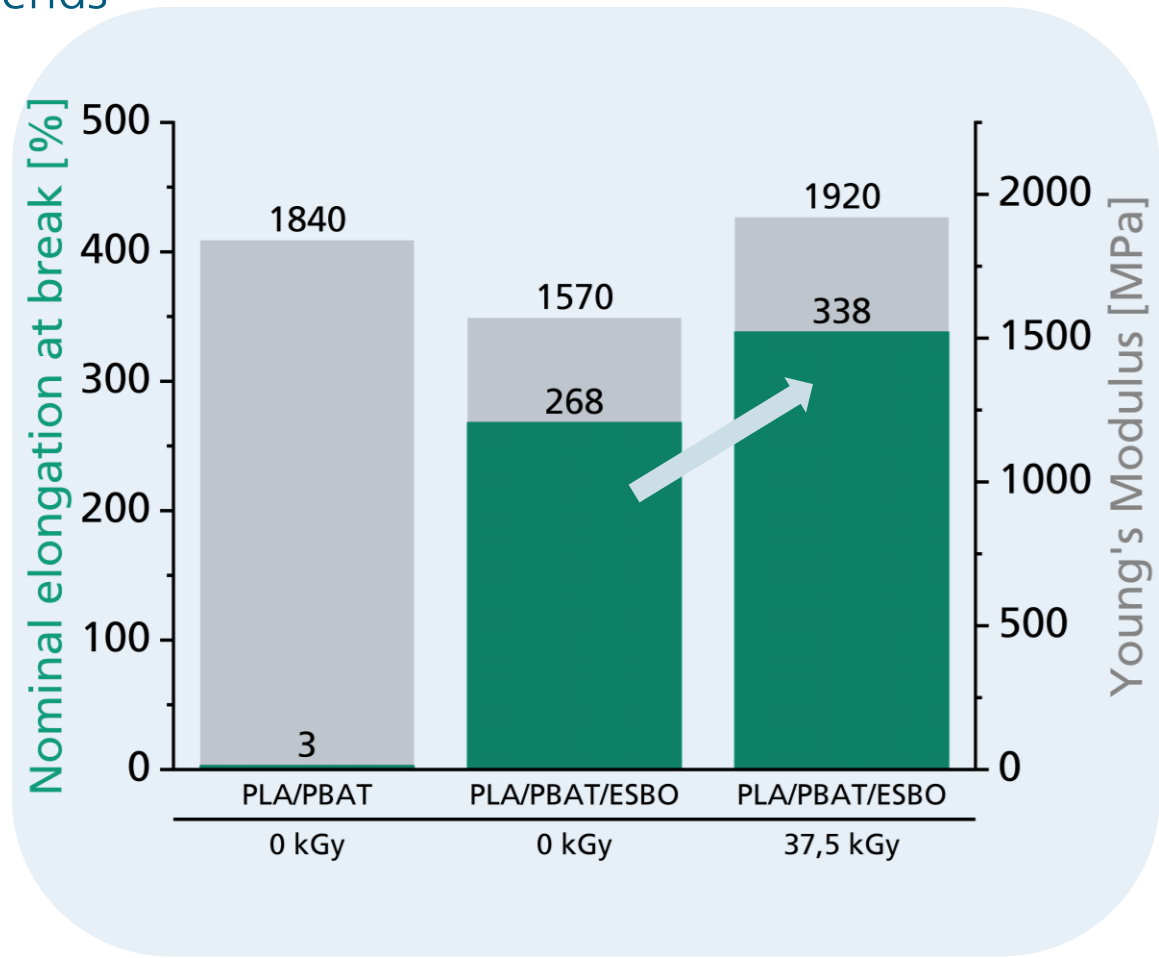
Schematic illustration of the proposed effects of the combination of compatibilizing agents with electron beam treatment

Polymer architecture

PhD study L. Marbach | Increasing PLA content in Blends



Nominal elongation at break without and with ESBO



Comparison of Nominal elongation at break and Young's Modulus

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Resource, performance, processing

TechPLAstic

Application and market-oriented development of PLA compounds as substitutes for conventional plastics such as ABS (acrylonitrile-butadiene-styrene copolymers) or PC (polycarbonates) in technical injection-molded components

Formulation development | Basic material

- Polylactic acid (PLA)

Requirements

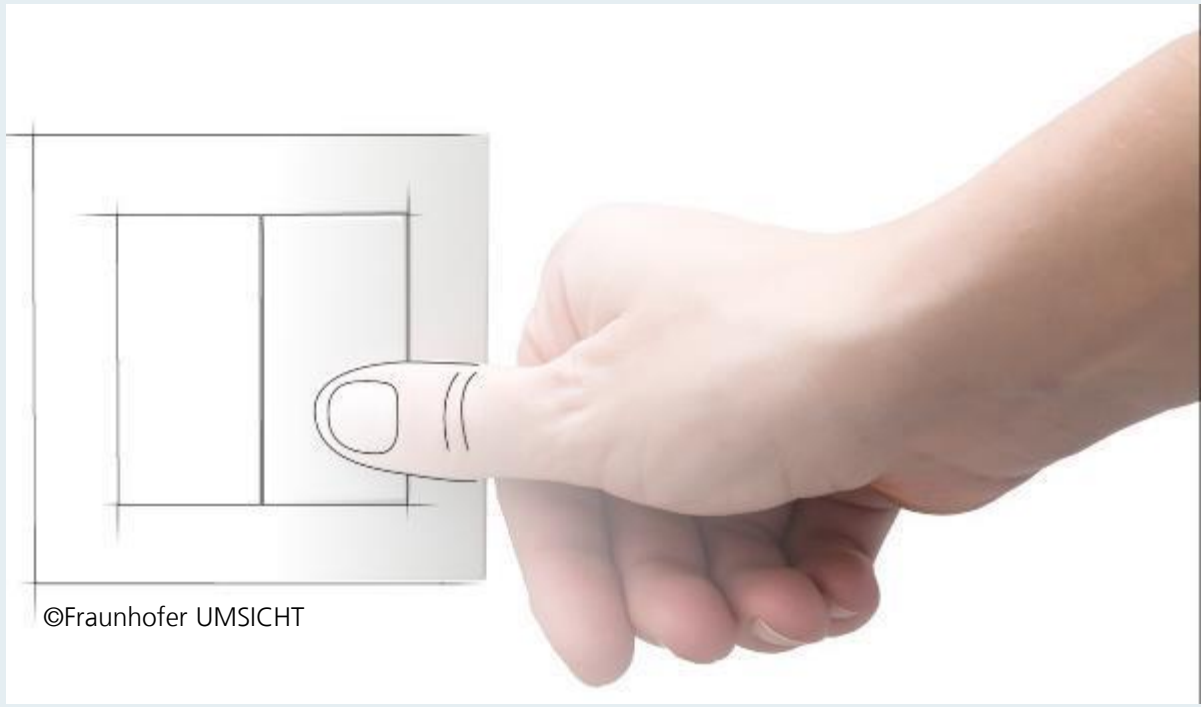
- Injection moldable
- Dimensional stability, flame retardancy, impact resistance

Application focus

- Electronics and building sector
- Lights or switches and buttons in building technology

Project partners

- Evonik Nutrition & Care GmbH, FKuR Kunststoff GmbH, Institut für Kunststoffverarbeitung (IKV) an der RWTH Aachen
- Supported by: Gira Giersiepen GmbH & Co. KG, ICL Industrial Products, Nabaltec AG, Alfred Pracht Lichttechnik GmbH



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Resource, performance, processing

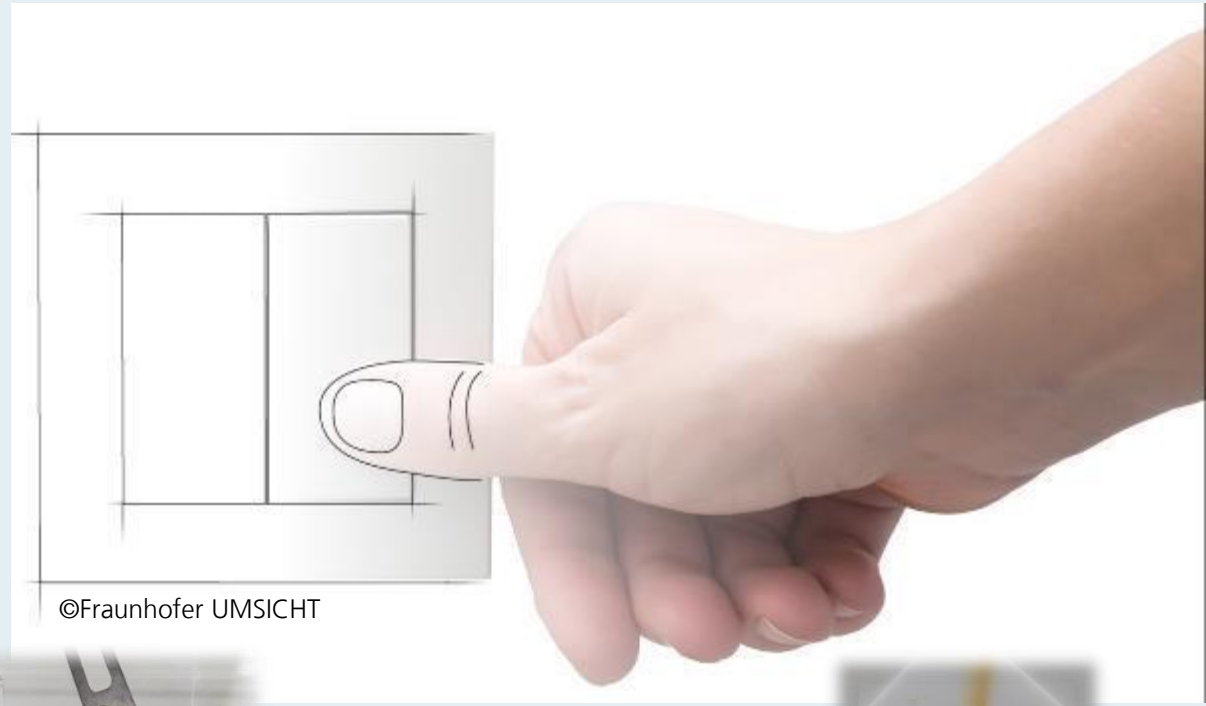
TechPLAstic

Results

- High impact resistance (Charpy),
- High heat deflection temperature (HDT)
- Flame retardancy (Glow wire test 850 °C)
- Approved mechanical recyclability

Application opportunities

- Various technical product solutions are based on these results



Impact-Resistance | Heat-Resistance | Flame-Retardent

Bioeconomy in the context of plastics products

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Resource, recycling, processing

Bio2bottle | Novel bottles made from bioplastics

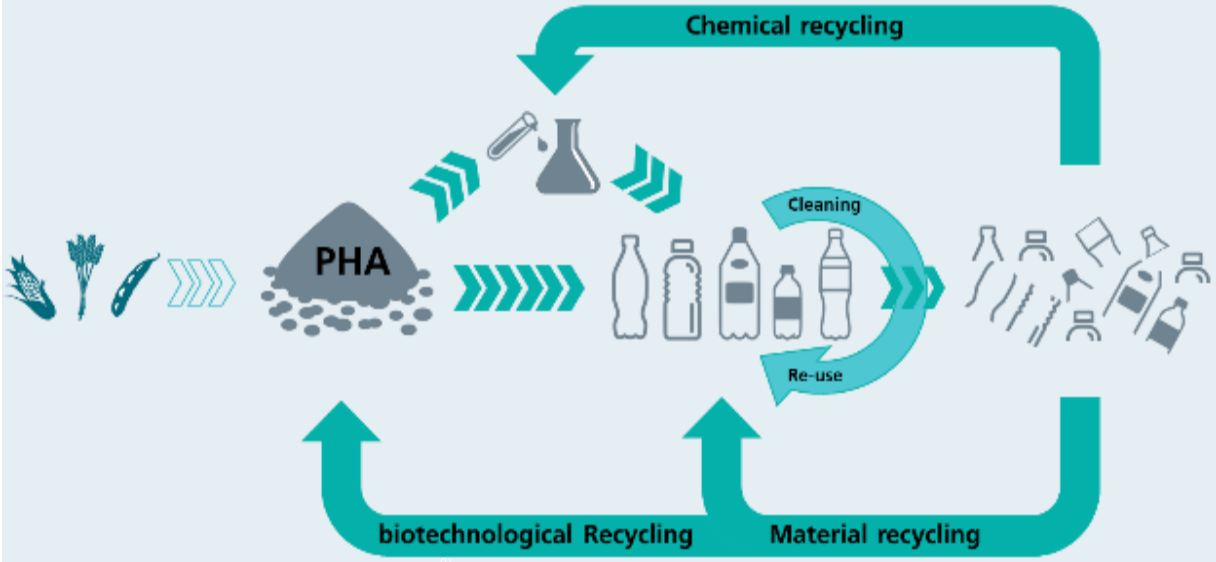
The entire value chain, from additive synthesis and material development to the final application of the bottles for an innovative cleaning agent and products for organic farming, such as plant growth-promoting soil additives

Formulation development | Basic material

- Polyhydroxyalkanoate (PHA)

Requirements

- Processability, mechanical stability
- Good barrier properties
- Recyclability
- Biodegradability



Bio2Bottle - Fraunhofer UMSICHT

Resource, recycling, processing

Bio2bottle | Novel bottles made from bioplastics

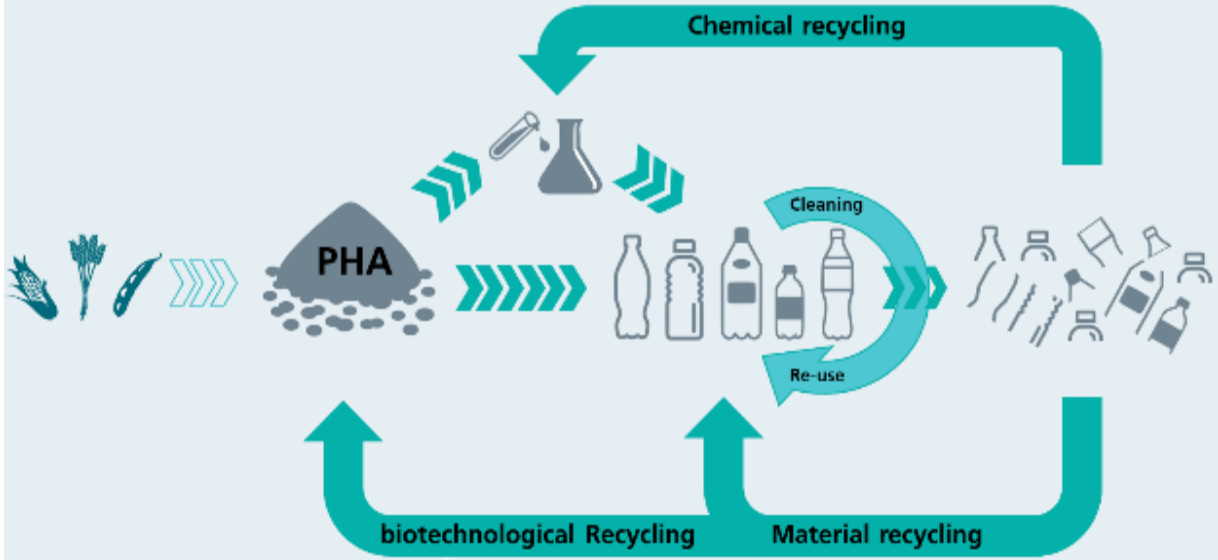
Process

- Fermentation
- Synthesis
- Compounding
- Extrusion blow molding

Recycling concepts

- Chemical
- Materially
- Biotechnological

- Official funded cooperation project



Bio2Bottle - Fraunhofer UMSICHT

Resource, recycling, processing

Bio2bottle | Novel bottles made from bioplastics

variation of the side chains

↓

melt viscosity

addition of bio-based polyester additives

↓

mechanical durability

degradable polyesters

process-controlled adjustment of crystallization behavior

↓

barrier properties

challenge: circular economy

Bioeconomy in the context of plastics products

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Light weight, resource, processing

Starch based foam film | ongoing cooperation project

Project objectives

- Regrowing resource starch
- End of life: composting
- Similar properties to fossil-based foam films
- Compatible with conventional plastic processing

Innovation

- Bio-based, continuously produced, foamed, flexible films

Partners

- Loick Biowertstoff GmbH, RWTH Aachen (IKV), SHS plus GmbH, Gefinex GmbH

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Light weight, resource, processing

RAFFINESS

Project objectives

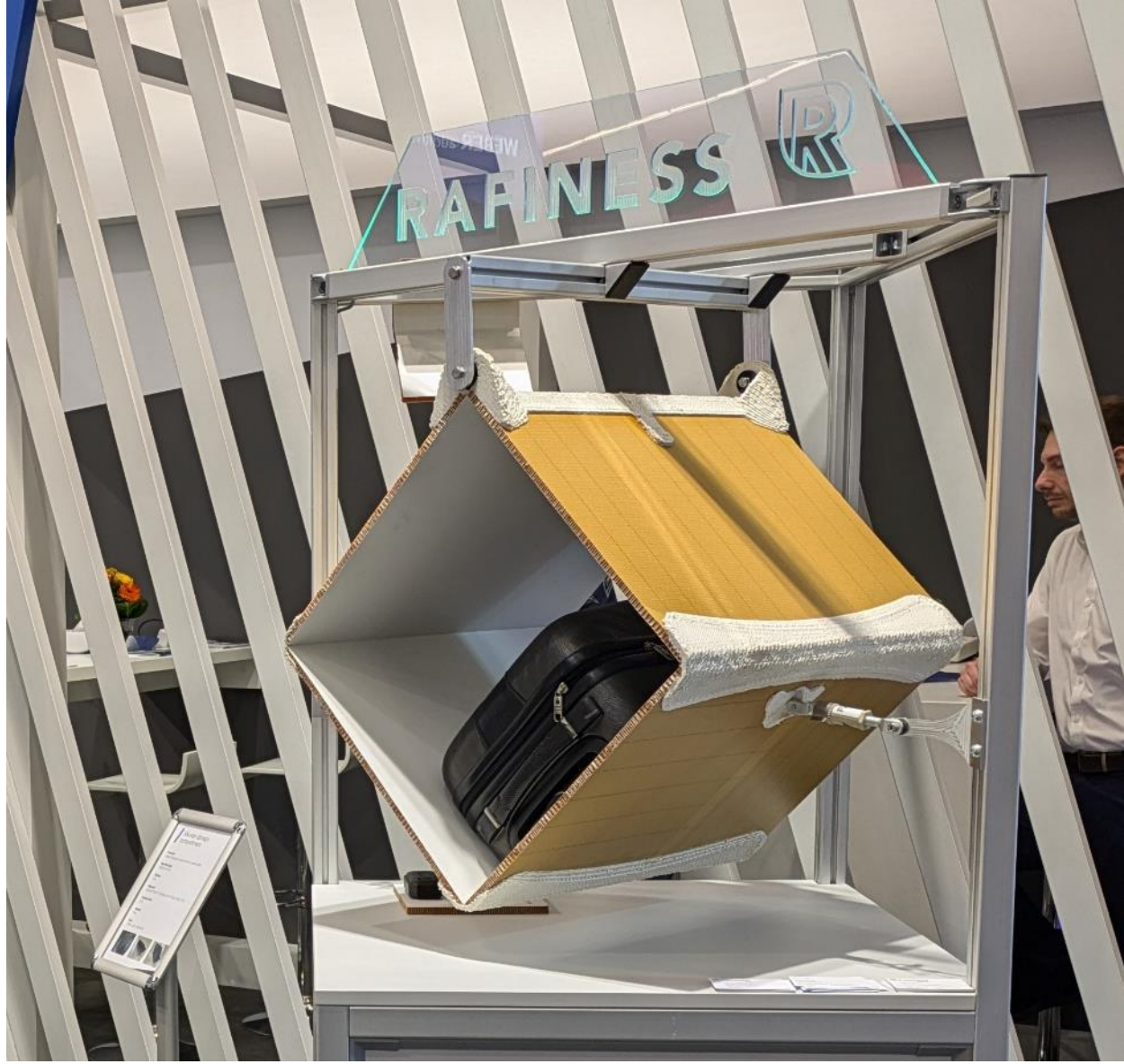
- Efficient use of materials through precise application
- Functional integration to reduce the number of material types
- Use of robot-assisted additive manufacturing (RAM) on honeycomb core panels

Material requirements

- High impact strength
- Flame and temperature resistant
- Optimized for precise application and low material waste

Partners

- ZAL Zentrum für Angewandte Luftfahrtforschung GmbH, Fraunhofer IFAM, SFS Intec GmbH



RAFINESS: Bio-based high-performance material - Fraunhofer UMSICHT

Light weight, resource, processing
RAFFINESS

Results

- Glass fiber reinforced, bio-based polyamide
- Combines stabilizers and processing aids
- High thermal stability prevents discoloration and smoke development
- Very low shrinkage → precise RAM process without detachment
- Post-processing (milling) possible without any problems

Benefits for aviation and beyond

- Reduced aircraft weight → lower fuel consumption and CO_2 emissions
- Improved recyclability due to fewer types of materials
- Additional fields of application: Injection molding (good flow properties, low shrinkage)
- Plant engineering, electronic components, flame and temperature resistant
- Optimized for precise application and low material waste

FEATURE	UNIT	TARGET	VALUE ACHIEVED
Tensile strength	[MPa]	>70	94
Impact strength	[kJ/m²]	>5	6,3
Elongation at break	[%]	>3	6,6
Flame protection according to UL94	[-]	V-0	V-0

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Life means consumption…
but our challenge as scientists is to develop materials that are sustainable and minimize our ecological footprint.

contact

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