



From the fundamentals of biodegradability to sustainable products

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What is biodegradability?

Humans



Microorganisms



Food biopolymers

(e.g., carbohydrates, proteins)

Cell material
(biomass)

Energy, CO₂,
water

“Food” biopolymers

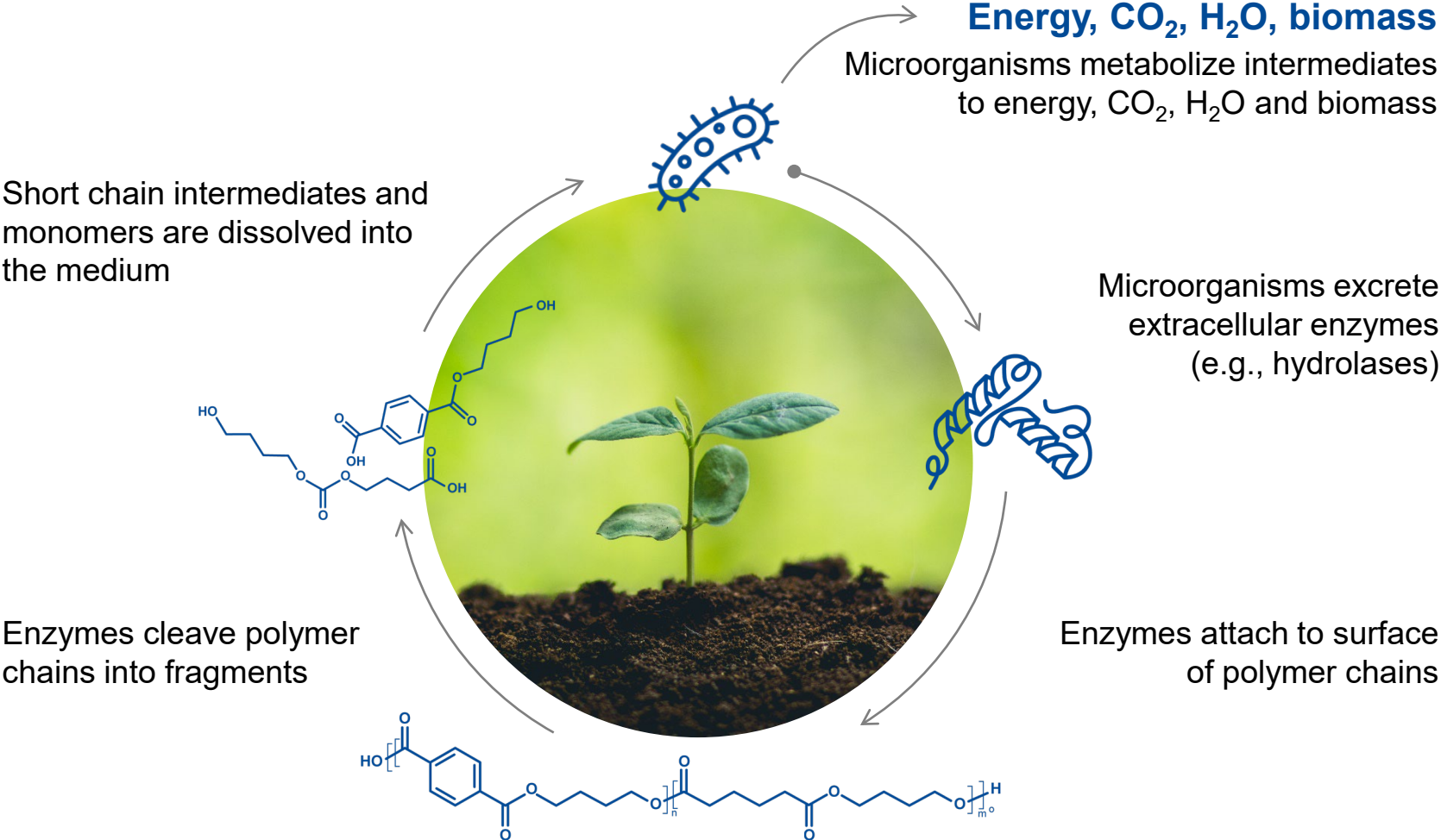
(e.g., carbohydrates, proteins,
synthetic biodegradable materials)

Cell material
(biomass)

Energy, CO₂,
water

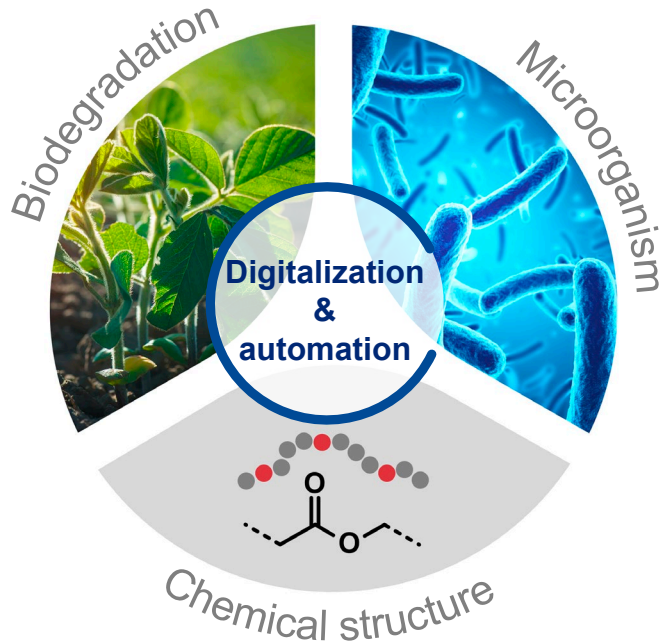
Biodegradation = Microorganisms metabolize the “polymeric” material completely into CO₂, energy, water and **biomass** (aerobic process)

General mechanism of polymer biodegradation



The fundamentals of biodegradability are the basis for sustainable new product developments in specific applications

Understanding the relationship between structure and biodegradability

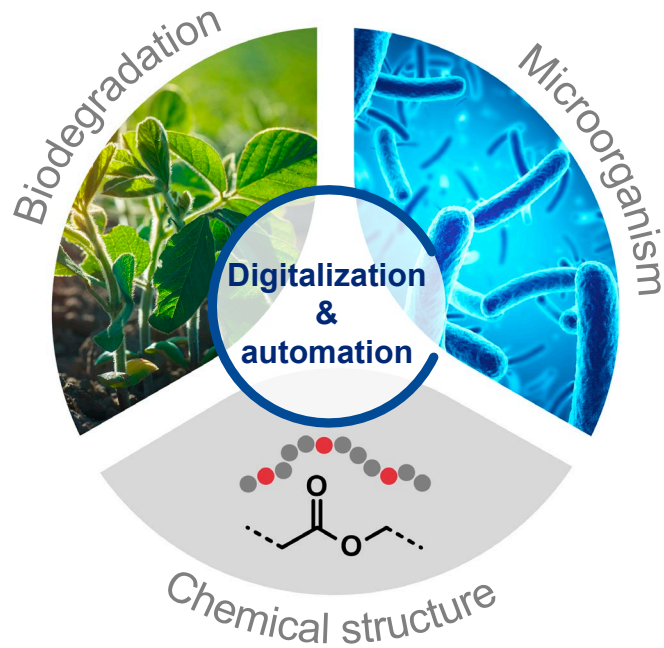


Development of new tailor-made certified biodegradable products



The fundamentals of biodegradability are the foundation for appropriate biodegradation standards and a constructive dialogue

Published scientific data of fundamental biodegradability mechanisms



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universität wien



Academic cooperations

Dialogue and development of biodegradation standards together with authorities and stakeholders along the value chain



Stakeholder cooperations

Certified soil-biodegradable ecovio® mulch film as contributor to sustainable agriculture

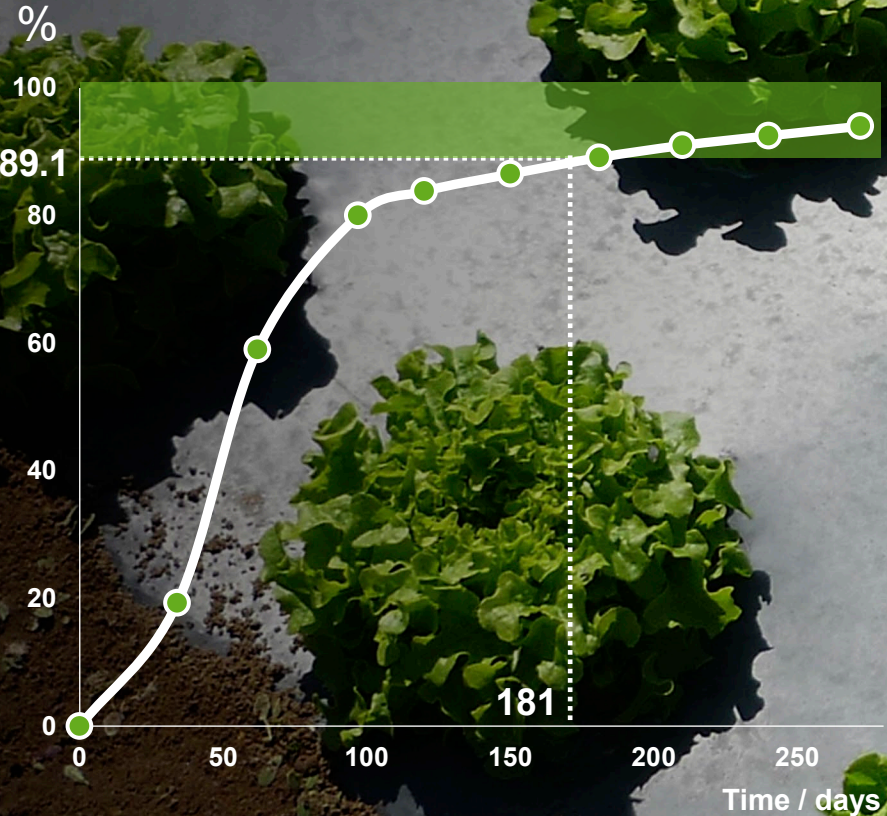
Dialogue, biodegradation standards and development of certified biodegradable products



ecovio[®] M2351 mulch – biodegradation in soil according to EN 17033



Biodegradation of ecovio[®] M2351 mulch film relative to cellulose control

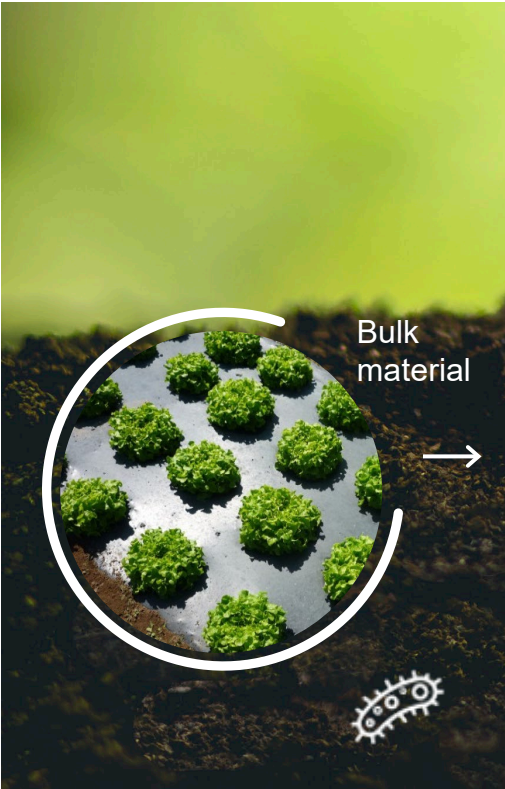


At **181 days**, **89.1%** biodegradation, relative to cellulose was measured – absolute biodegradation of **94.4% ($\pm 1.7\%$)**.
Where is the rest?

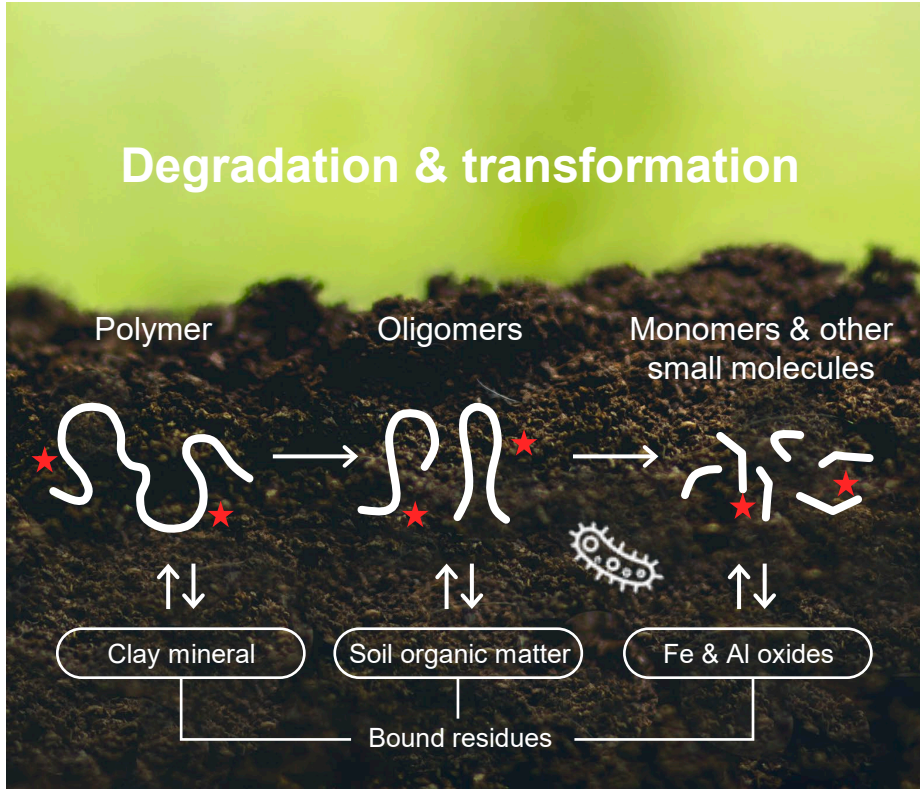
Decisive methods for understanding ecovio[®] mulch film's biodegradation in soil



1 Microbial colonization

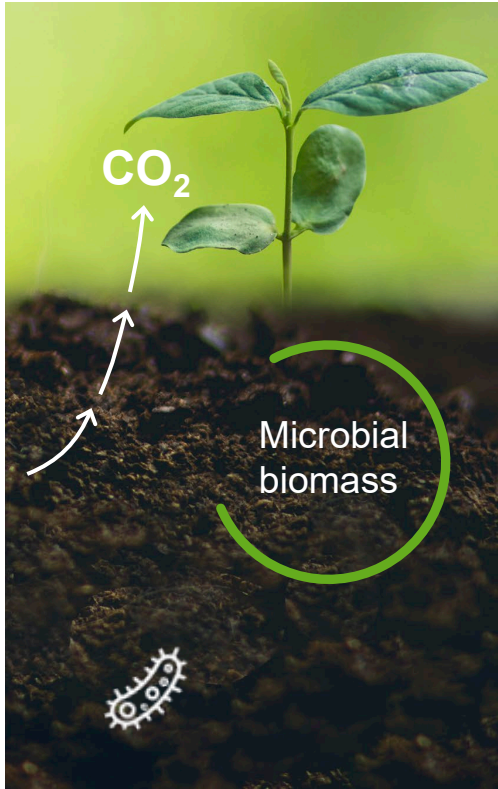


2 Enzymatic hydrolysis



★ Modified ¹³C labeling of the monomers

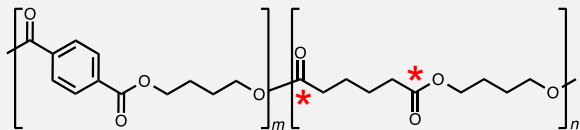
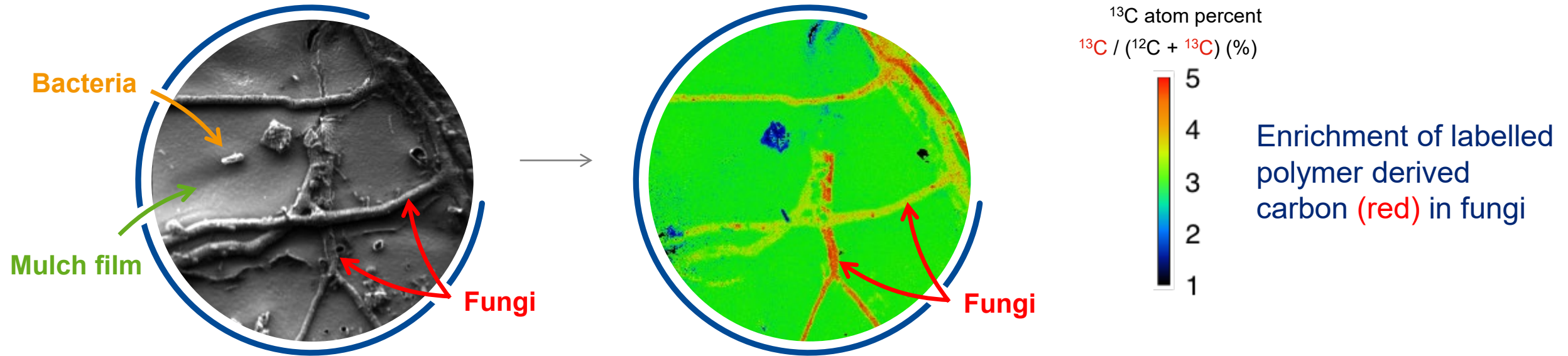
3 Microbial metabolism



Where does the polymer carbon end up?

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Conversion into microbial biomass shown by nanoscale secondary ion mass spectrometry (NanoSIMS)



poly(butylene adipate-co-terephthalate)
PBAT: labeled in adipate

Images reprinted with permission of AAAS. From Zumstein et al., Science Advances 2018;4: eaas9024.

★ Modified ^{13}C labeling of the monomers

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Conversion of PBAT (all monomers) into microbial biomass has been proven.

Certified soil-biodegradable ecovio® mulch film as contributor to sustainable agriculture



700

microbes can biodegrade ecoflex® and ecovio®

6

publications in high impact journals

Nature Communications, Science Advances et al.

60

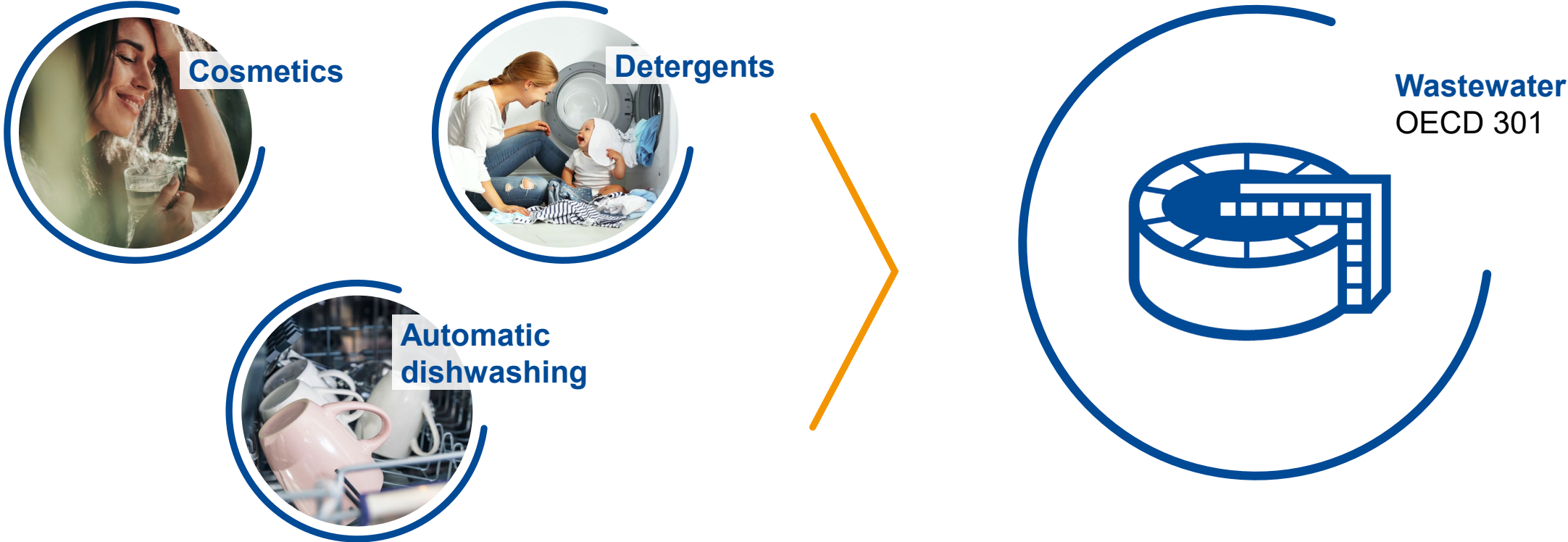
different soils were investigated

Investigation in field trials is ongoing

- Certified soil-biodegradable ecovio® mulch film as sustainable alternative to thin polyethylene mulch film
- Results of this long-term academic partnership are the basis for the development of further certified soil-biodegradable products

Functional biodegradable materials with multiple sustainability benefits

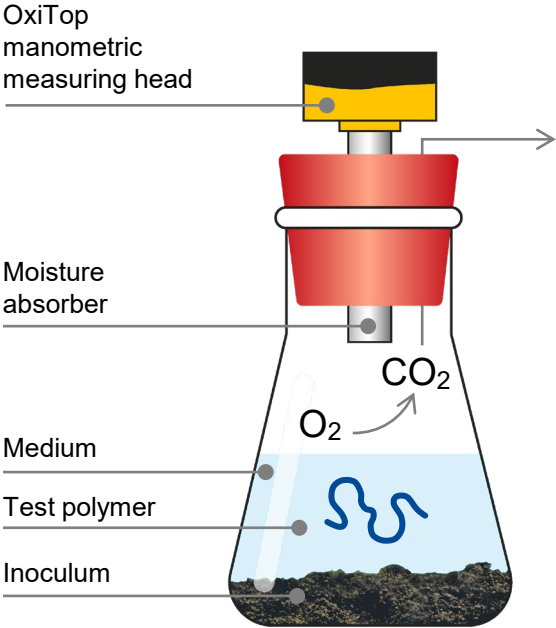
Biodegradation standards and development of new tailor-made certified biodegradable products



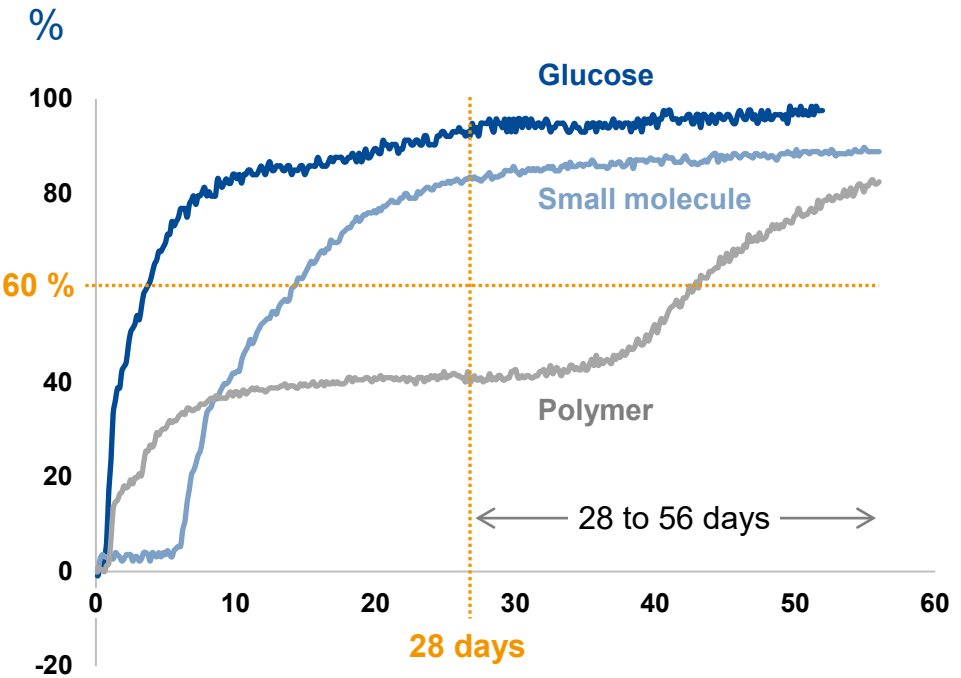
Method development to address different types of biodegradable functional materials in an appropriate way



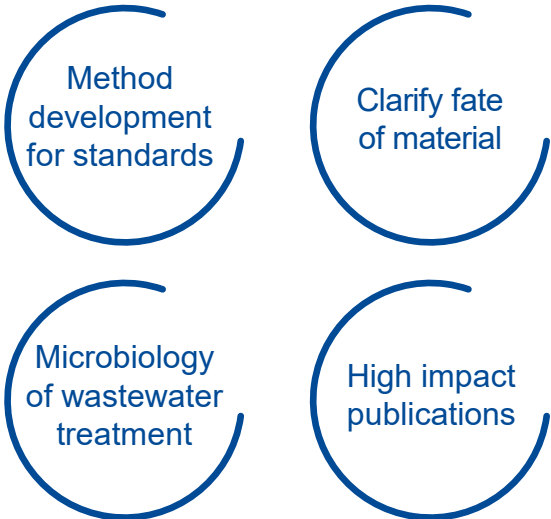
Test substance



Biodegradation of functional materials



Fundamental approach and targets



BASF is proactively developing decisive test methods and an understanding of biodegradation of functional materials in wastewater treatment plants.

Broad BASF portfolio of biodegradable functional materials



Automatic dishwashing

- **Trilon® M Max** – high-performance alternative to phosphate in automatic dishwashing



Detergents

- **Lavergy® Pro** – increased sustainability and washing performance (e.g., washing at lower temperature)



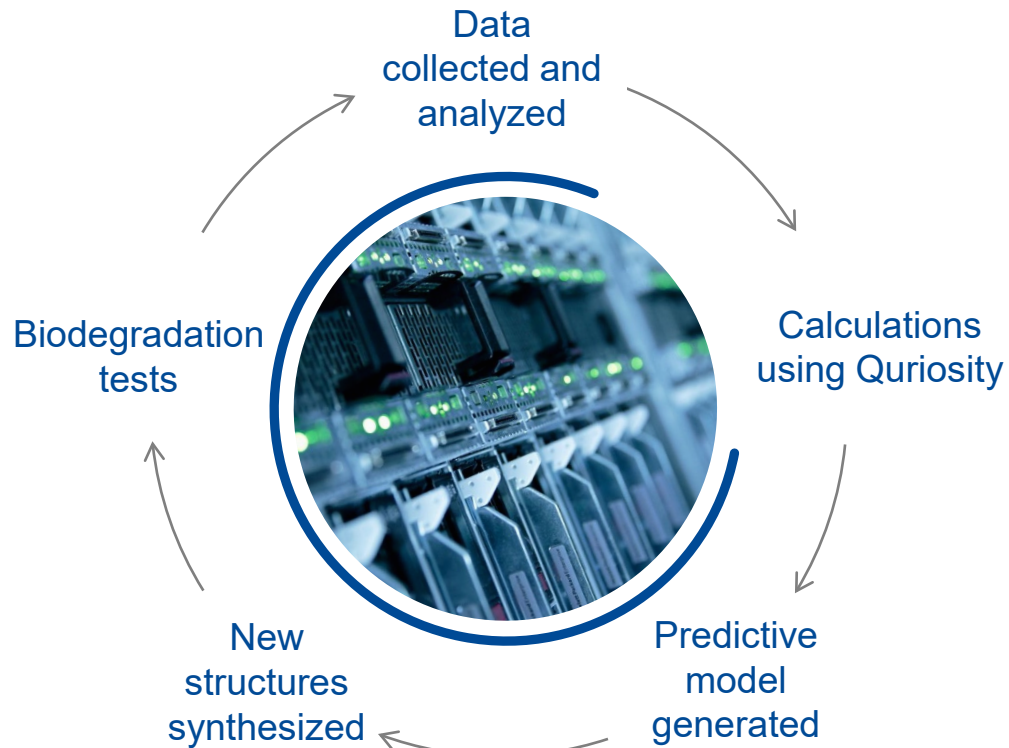
Cosmetics

- **Verdessence™** line of biopolymers, including natural polysaccharides

BASF has contributed to improved sustainability performance with innovative solutions and is expanding the toolbox with new products.

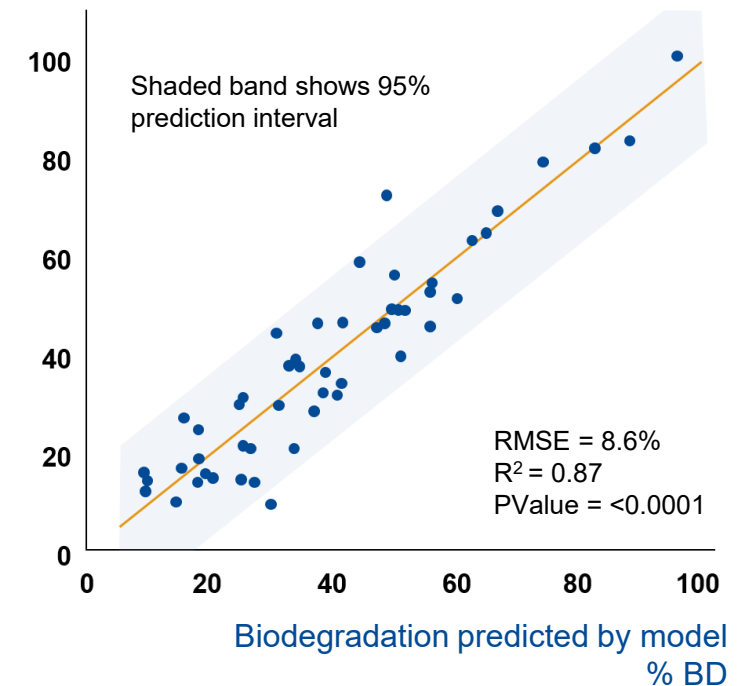
Predictive biodegradation modelling for acceleration of new product developments to enlarge portfolio

How is a model developed?



Model correlation with lab tests:

Biodegradation in biotest
%, OECD 301, 28d



A novel machine learning model accurately predicts the biodegradation of polymers in different end-of-life environments.

From the fundamentals of biodegradability to sustainable products

1 **Microorganisms** metabolize the biodegradable polymeric material completely to **CO₂, energy, water** and **biomass** (aerobic process).

2 **Certified biodegradable materials** contribute to the circular economy in specific applications with defined end-of-life options.

3 **High-level science through academic partnerships** is the basis for product development, a contribution to standards development and a constructive fact-based discussion.

4 **Fate of certified soil-biodegradable mulch film** has been shown and **published in high impact scientific journals**.

5 **BASF** is proactively **addressing all aspects of biodegradable functional materials** for an open dialogue with all stakeholders.

6 **Predictive biodegradation modelling** is a pioneering tool to validate the scientific data and **accelerate new product developments**.





We create chemistry