“Zertifizierte biologisch abbaubare Kunststoffe – vom Grundlagenverständnis zum Produkt”

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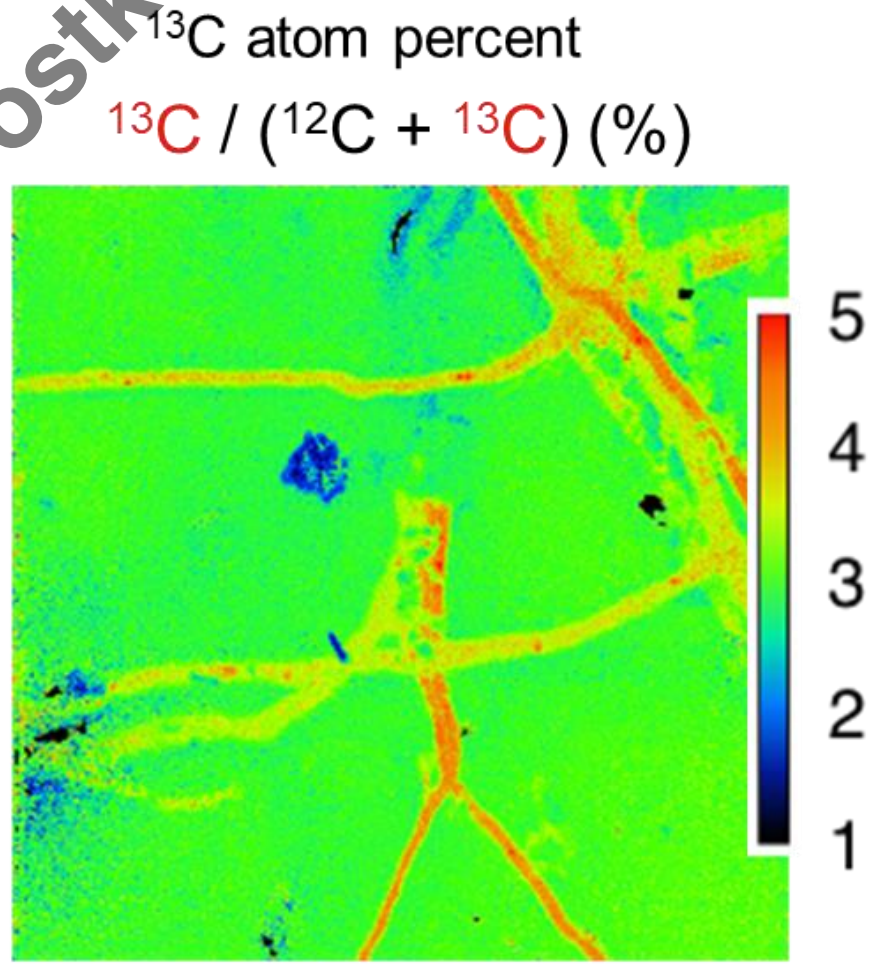
Kompostkongress Österrreich

Wieselburg, Austria, November 2022



Biodegradation

The circular economy vision with use of biodegradable and biobased materials – how to close the nutrient loops

Mulch Films

“Biosackerl”

➔ Biodegradable polymers as enabler for organic waste recycling and closing the loop – case study “Biosackerl” in Austria

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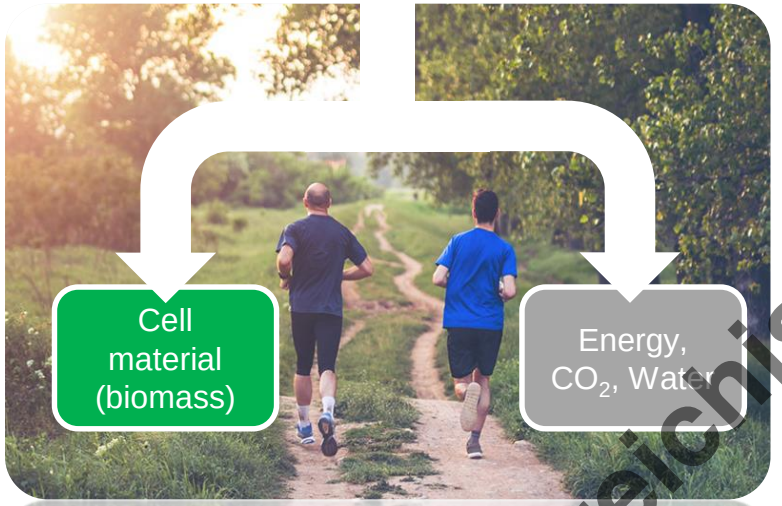
Biodegradability understanding

The purpose of biodegradation

Humans

Food biopolymers

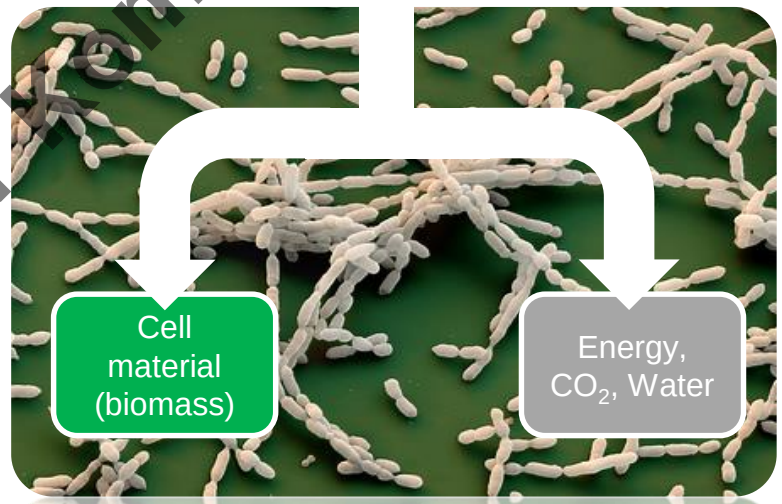
(e.g. starch, proteins)



Microorganism

„Food" biopolymers

(e.g. starch, proteins, synth. biodegr. polymers)



Biodegradation = microorganisms metabolize the polymeric material completely to **energy, CO_2, water** & **biomass** (aerobic process)

Mechanism of biodegradation related to polymer structure

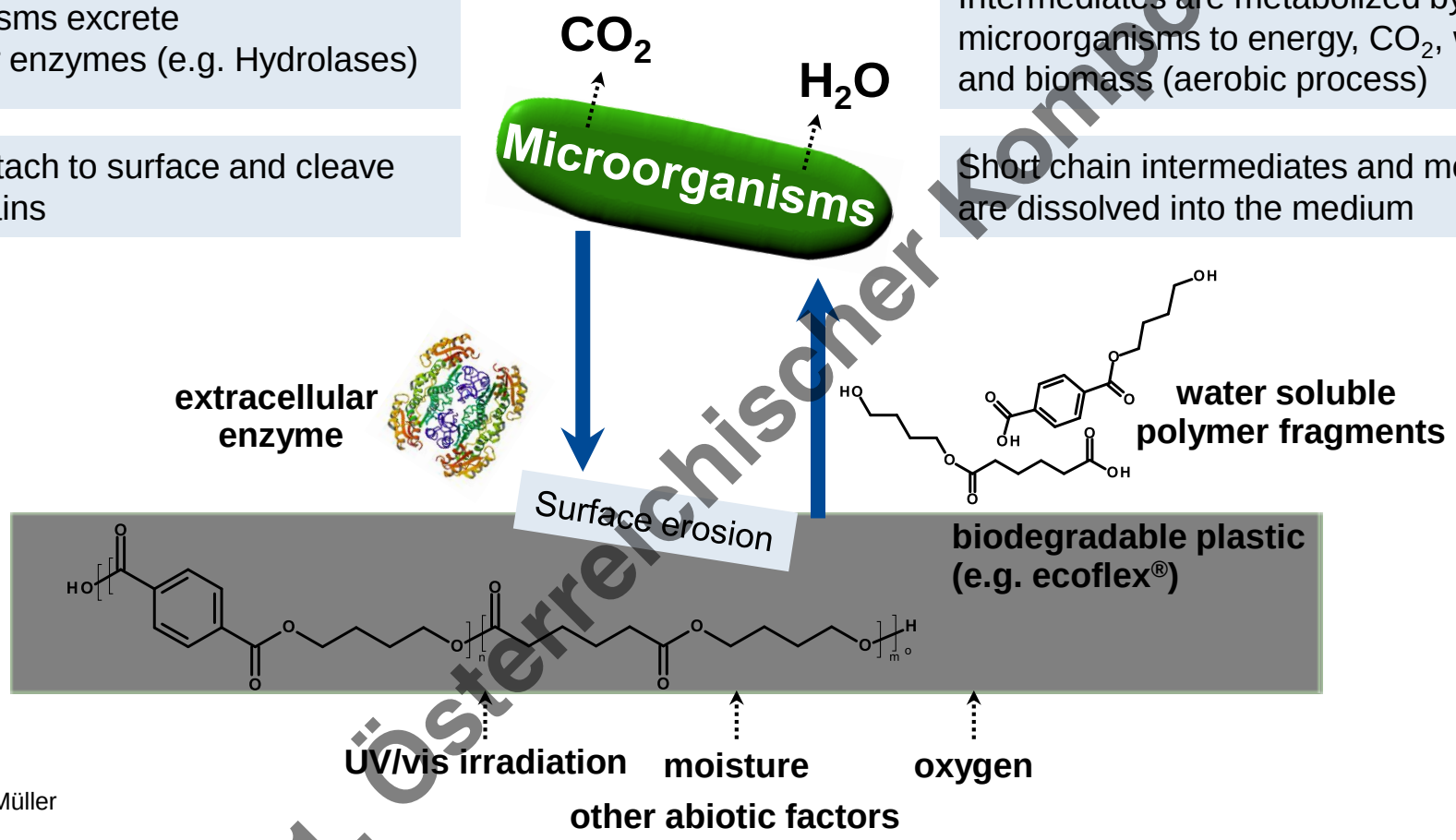
General mechanism of polymer biodegradation

Microorganisms excrete extracellular enzymes (e.g. Hydrolases)

Enzymes attach to surface and cleave polymer chains

Intermediates are metabolized by microorganisms to energy, CO_2, water and biomass (aerobic process)

Short chain intermediates and monomers are dissolved into the medium



adapted from R.J. Müller

Microplastic

What are microplastics?

Microplastics are pieces of plastic which are less than 5mm in size. There are 2 types of microplastic:

Primary Microplastic

- Enter the environment **directly from a product** (e.g., exfoliating beads being washed into wastewater from personal care products)

Secondary Microplastic

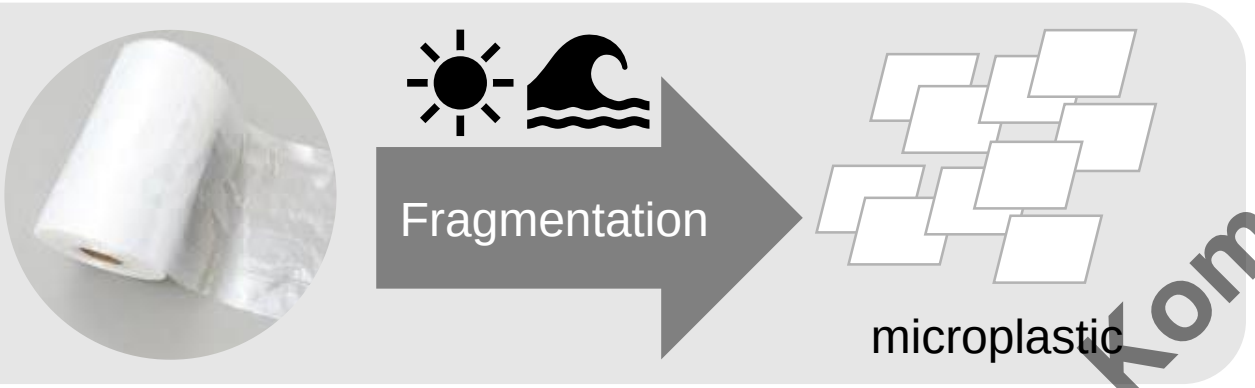
- Enter the environment via **breakdown of larger plastics** (e.g., degradation of plastics due to weathering)

Microplastics generated from conventional plastics are NOT biodegradable. They accumulate and persist in the environment

Microplastic

Breakdown of conventional vs. certified compostable plastics

Conventional Plastics – e.g. LDPE



- Fragmentation occurs via external processes such as sunlight or wave erosion
- These fragments create persistent microplastic

Certified compostable plastics – e.g. ecovio

Certified compostable plastics also fragment during composting, but are then completely biodegraded by microbes to biomass, water and CO_2

Microplastic

Microplastic extraction methods

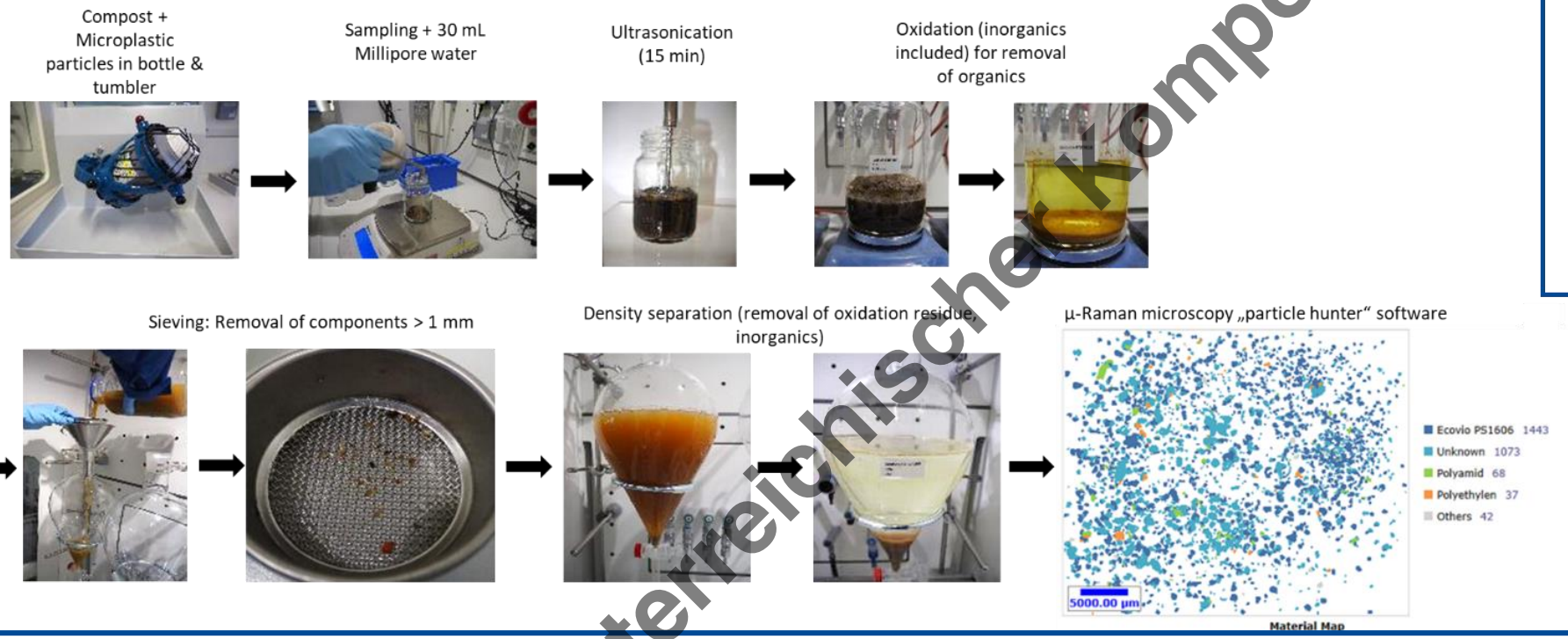
Pfohl *et al. Microplastics and Nanoplastics* (2021) 1:8
https://doi.org/10.1186/s43591-021-00009-9

Microplastics and Nanoplastics

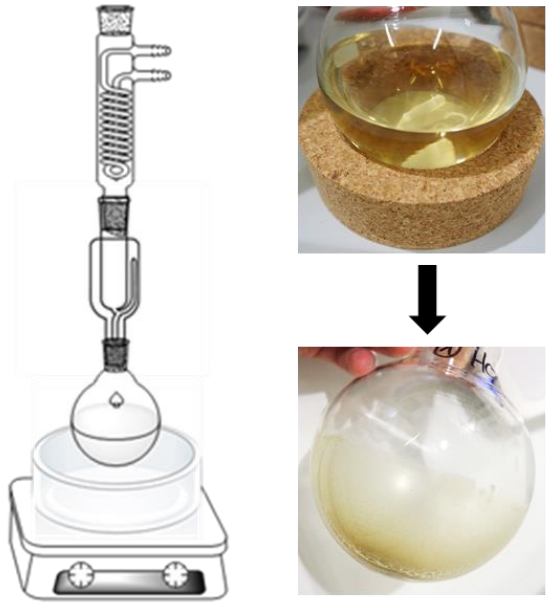
Microplastic extraction protocols can impact the polymer structure

Patrizia Pfohl[1], Christian Roth[1], Lars Meyer[1], Ute Heinemeyer[1], Till Gruendling[1], Christiane Lang[1], Nikolaus Nestle[1], Thilo Hofmann[2], Wendel Wohlleben[1] and Sarah Jessl[1,3*]

Particle extraction



Soxhlet extraction



Total polymer mass/ molar mass distribution

Fragment number/size/shape/identity

Fundamental understanding of biodegradability

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ecovio® PS1606 extrusion paper coating grade: biobased & certified compostable

ecovio® is the trade name for BASF's compounds based on ecoflex® + Polylactic acid (PLA)

ecovio® PS1606 extrusion paper coating grade

74% average bio-based carbon content

OK biobased | TÜV AUSTRIA ★★★ S0062

Certified industrial compostable

OK compost | TÜV AUSTRIA INDUSTRIAL S0062 — European Standard EN 13432

compostable — European Standard EN 13432, Australian Standard AS 4736

BPI COMPOSTABLE — COMMERCIALLY COMPOSTABLE ONLY. FACILITIES MAY NOT EXIST IN YOUR AREA. CERT #890989 — American Standard ASTM D6400, ASTM D6868

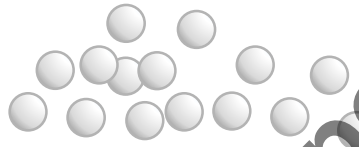
グリーンプラ 生分解性プラスチック — Japanese Standard GreenPla

* Determined by methodology conform to ASTM D 6866

3 Scenarios of ecovio PS1606 biodegradation in compost were investigated

A. Granules

Micronised



3D micro-granules

B. Film

Micronised

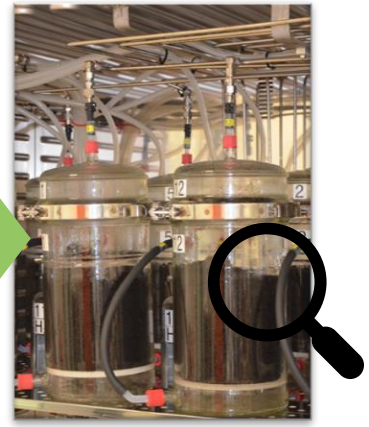
2D film pieces

C. Coated paper

Shredded

2D film-on-paper pieces

Composting



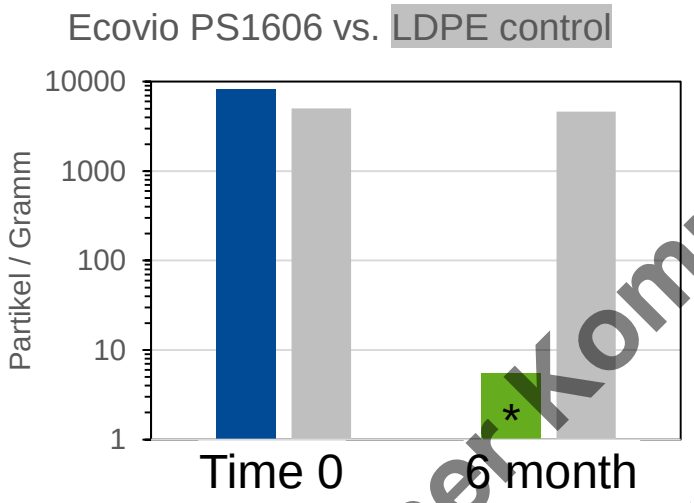
Micronised = artificial fragmentation through physical milling

Microplatstic

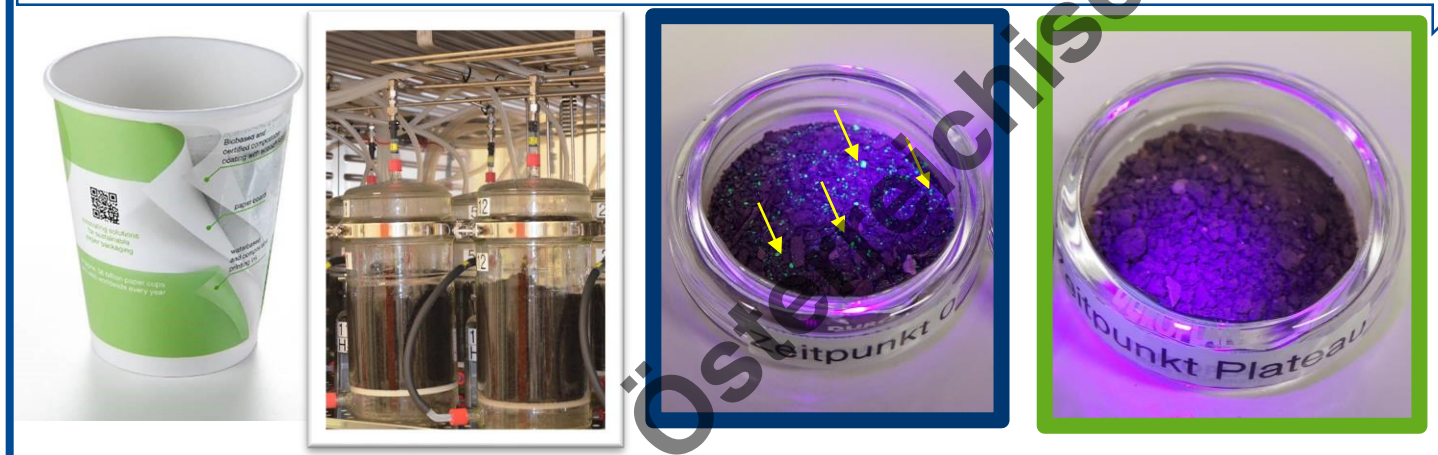
Compostable plastics (ecovio PS 1606) and the microplastic question

LDPE fragments in idustrial compost:
No degradation

ecovio fragments in industrial compost:
Minimum 99.93% (detection limit) of particles disappear. We detect 100% of expected compostion (*)



ecovio PS1606 **Composting** **timepoint_0: fragments** **CO_2_6 month: No fragments**



Technology developed (status Sept. 22)

- Adapted extraction methods from universities. Validation via controls with low number of particles per gram compost
- Identification & size determination via colour-labelled fragments / spectroscopic methods
- Correlation of CO_2 tracking and particle analysis

Result

- The generated ecovio PS1606 fragments – as part of the overall process – undergo a biodegradation process
- Publication submitted

Path forward

- Validation of other ecovio grades
- Development of a standard to determine microplastic in compost

Approach with new tools

Predictive biodegradation modelling

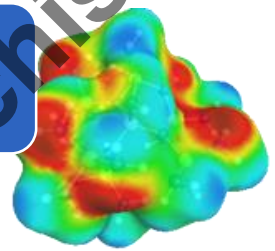
How is a Model Developed?

Biodegradation Tests

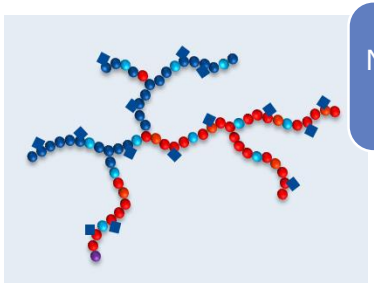
Data Collected and Analyzed

Calculations on Quriosity

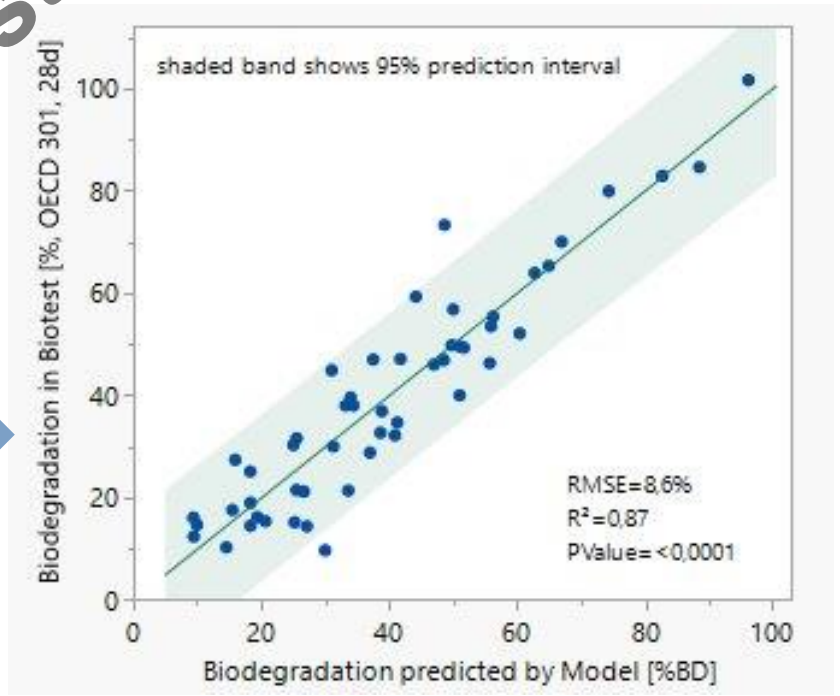
Predictive Model generated



New structures synthesized



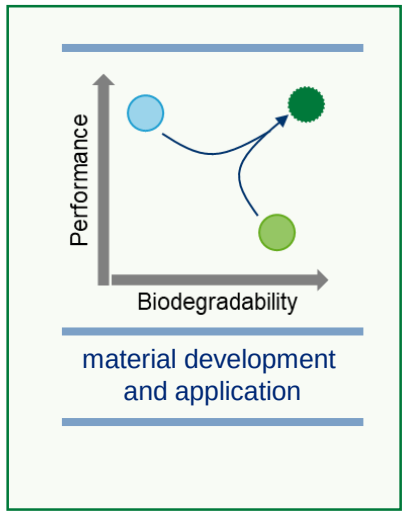
Model correlation with lab tests:



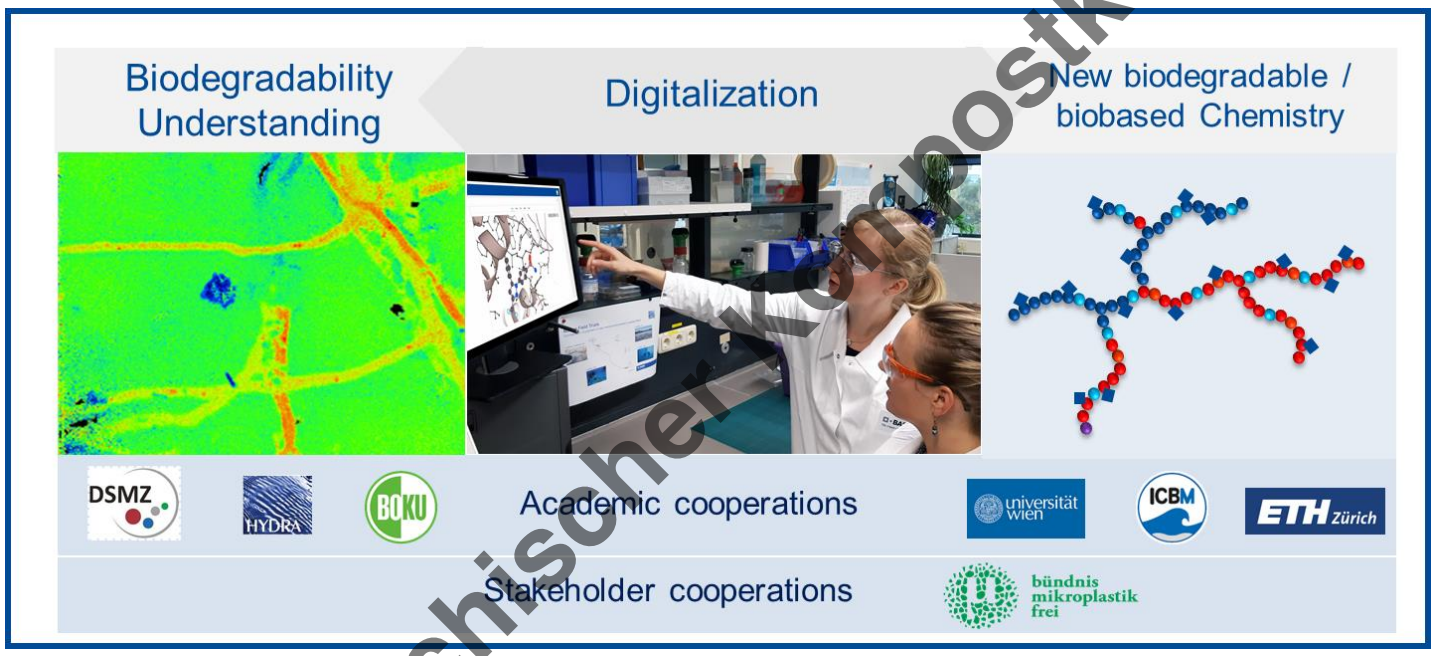
A novel machine learning model which accurately predicts the biodegradation of polymers in different end-of-life environments

Research biodegradable and biobased materials

Combine biodegradability understanding and new chemistry with digitalization



material development and application



standard development and stakeholder dialogue

Provide know how for biodegradable and biobased material development, standard development and stakeholder dialogue to shape together a framework for the use of different biodegradable and biobased materials contributing to a circular economy

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