



Biodegradable mulch film – clarification of polymer fate in soil

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Biopolymers Research BASF SE
CIPA Congress 2018
Bordeaux / Arcachon, France, May 2018

Biodegradable mulch film ecovio® M2351 mulch



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

ecoflex[®] as modular system

PB~~ST~~
(ecoflex[®])



Melt polycondensation

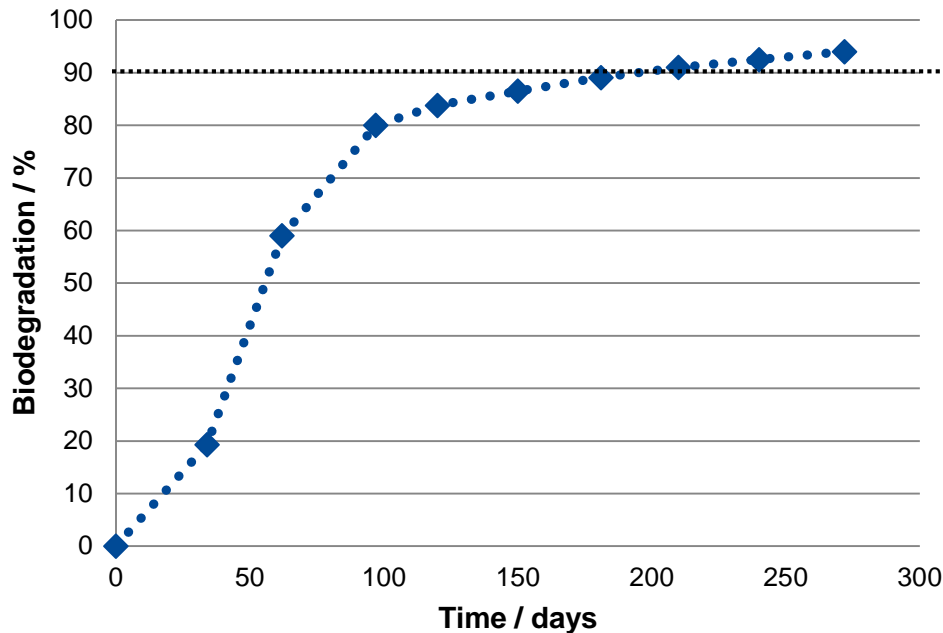


- ecoflex[®] is a random aliphatic-aromatic copolyester
- Access to biobased ecoflex[®] variants possible (e.g. by replacing adipic acid with biobased succinic acid)
- Each monomer change influences melting point, tensile strength, crystallization speed & **biodegradation behavior**

➔ Change of monomer and monomers composition results in new properties

ecovio® M2351 mulch – Biodegradation in soil according to ISO 17556

**Biodegradation of ecovio® M2351 mulch
film relative to cellulose control**



→ At 181 days an absolute biodegradation of 94.4% (±1.7%) was measured = 89.1% relative to cellulose

AIB-VINÇOTTE International s.a. / n.v.
SAFETY, QUALITY, ENVIRONMENT
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E-Mail : okbiodegradable@vincotte.be

OK bio-degradable
VINÇOTTE

**CERTIFICATE FOR AWARDING AND USE OF THE
"OK BIODEGRADABLE SOIL" CONFORMITY MARK**
No. O 14-1416-A

Issued by AIB-VINÇOTTE International

For the product(s) described hereafter :

Product Domain :	Products Biodegradable in SOIL
Product Group :	Raw materials
Product Family :	Bio material
Product Type :	In form of Resin or Granulates
Trade mark :	ecovio® M2351
Product description / Particularities :	Colour natural white

Conformity examination applied for by :

BASF SE
G-PM/PB - F206
c7164 Ludwigshafen
Germany

Criteria for certification :

AWI Test Program with test OK 10 edition C "Bio-products - degradation in soil"

Validity of the certificate :

From 25 September 2014 till 25 September 2019

Conclusions of the examination :

The products comply with the above mentioned certification criteria, as confirmed by the test report of AWI no 09 / 60159490 / 409344p.

Applicable certification system :

Type examination followed by supervision through verification tests on samples from the distributor's stocks or of the market.
The conformity of the product is guaranteed by the procedures for awarding and use of the "OK biodegradable SOIL" conformity mark. This only applies for specimen bearing the "OK biodegradable SOIL" mark.

This certificate is issued in English, German, Italian, French and Spanish.

Brussels, 25 September 2014

P. Michiels
P. MICHELIS
Contract Manager

Ph. Dewolfs
Ph. DEWOLFS
President of the Committee

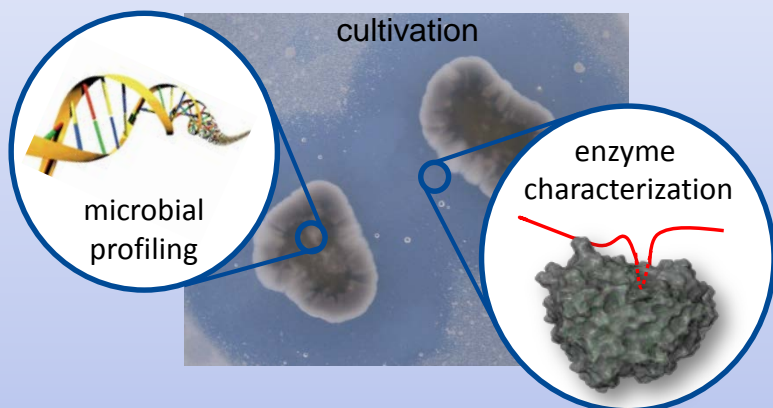
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08-CERTOKS-e

Basic understanding and field evaluation are both needed to understand biodegradability

Fundamental understanding

Elucidating structure-
biodegradability relationship



Polymer characteristics



Microorganisms and enzymes



Abiotic factors

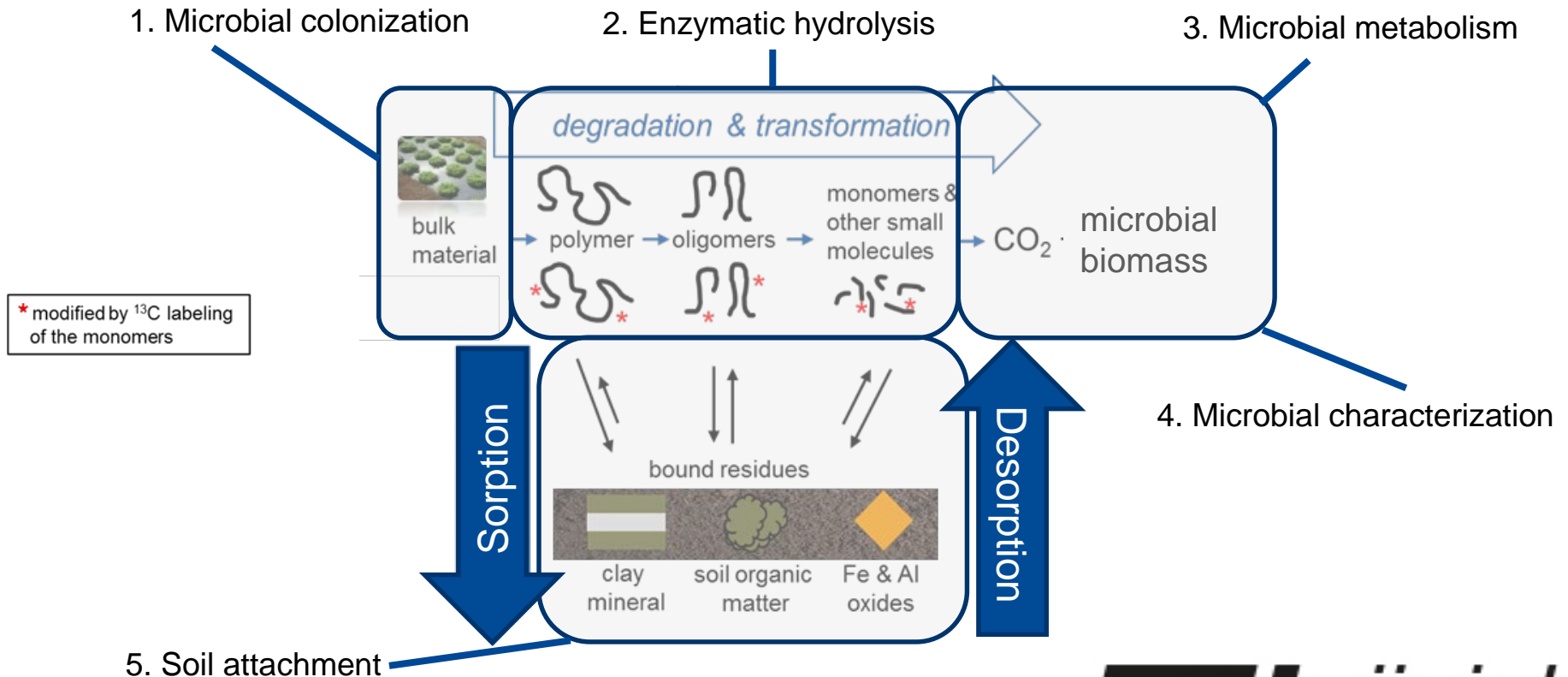
Field evaluation

Assessing product performance
in field trials



→ Biodegradation = microorganisms metabolize the polymeric material completely to CO₂, energy, water & biomass (aerobic process)

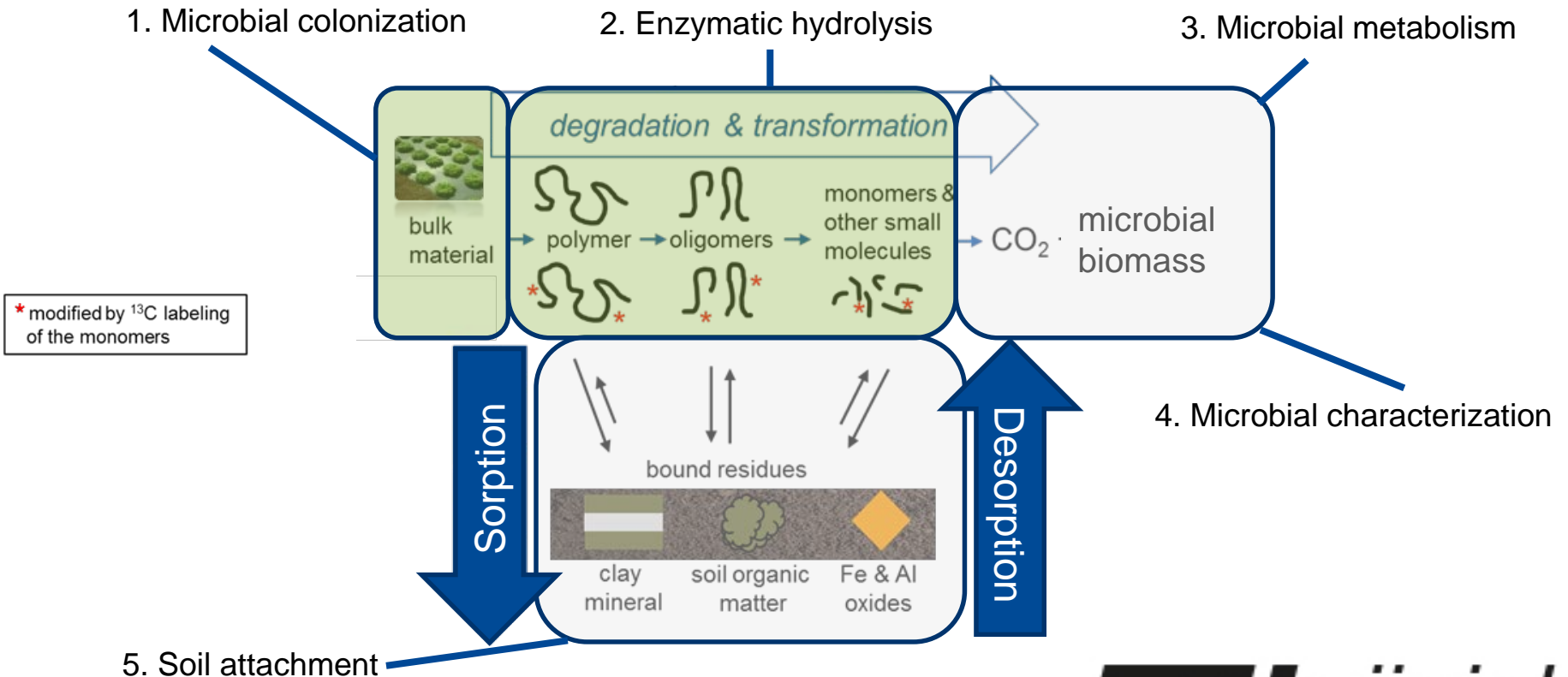
Decisive methods for understanding biodegradation in soil of ecovio mulch film



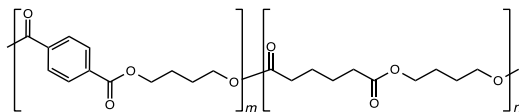
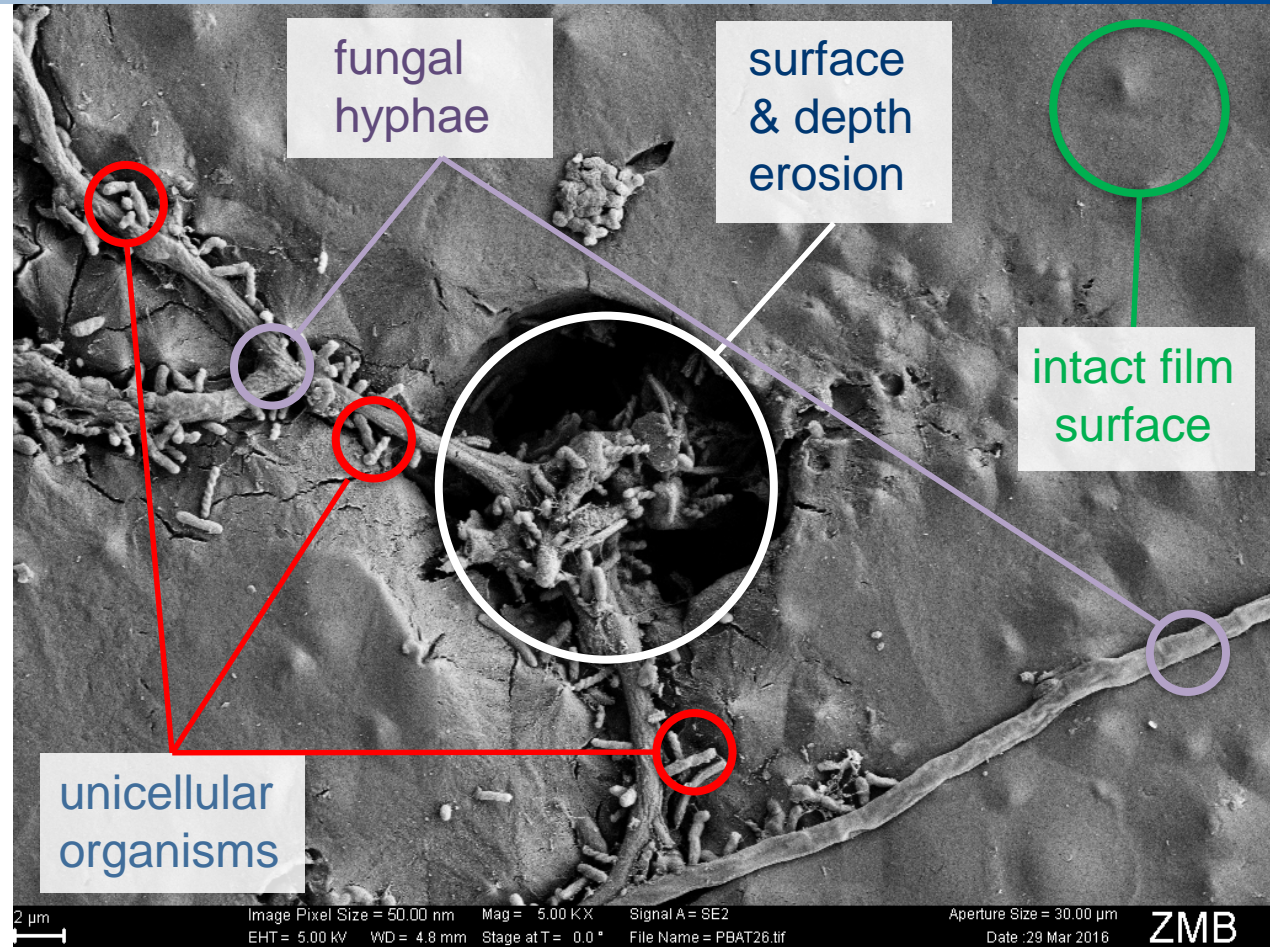
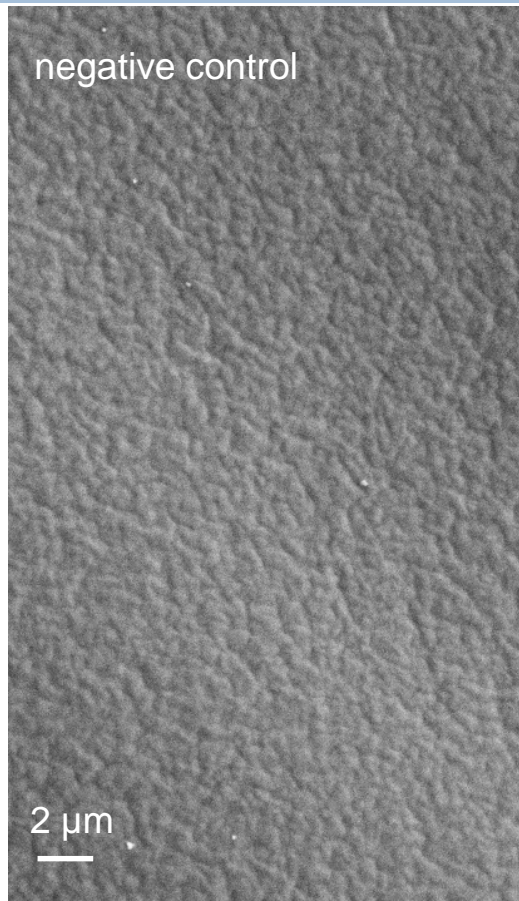
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→ Where does the polymer carbon end up?

Decisive methods for understanding biodegradation in soil of ecovio mulch film



1. Microbial colonization Polyester (PBAT) in agricultural soil



Laboratory experiments
Incubations in agricultural soil
→ 6 weeks @ 25°C

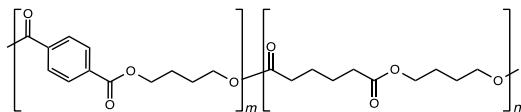
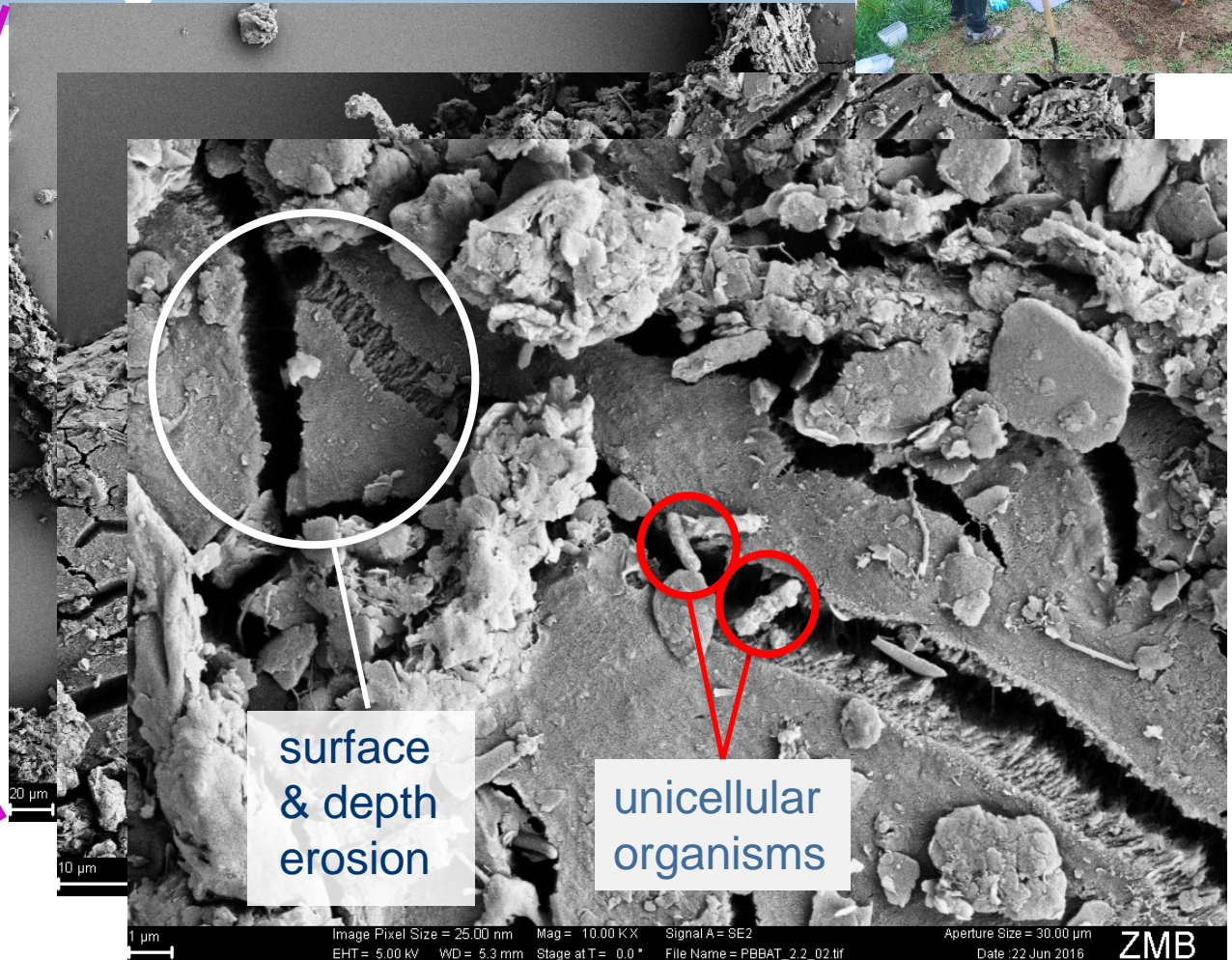
Scanning electron
microscopy images

1. Microbial colonization Polyester (PBAT) in agricultural soil



Field experiments

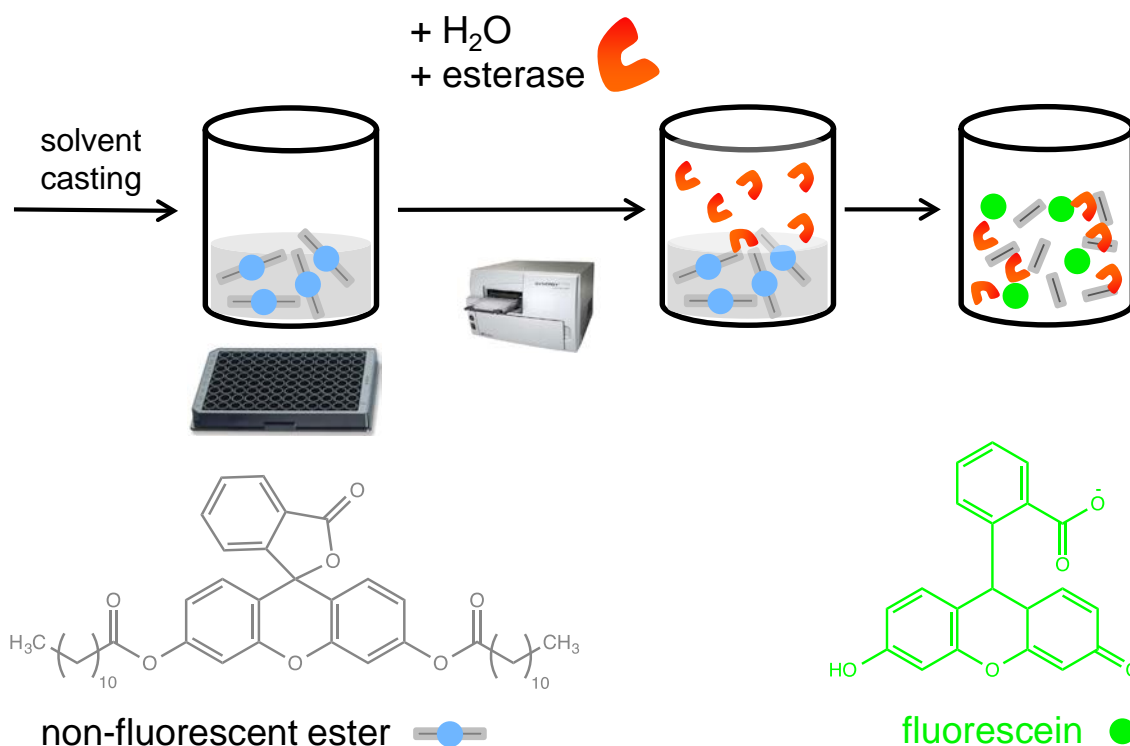
Incubations in agricultural soil
→ 6 months



→ Similar features on films from field and lab studies

2. Enzymatic hydrolysis

Novel techniques to study enzymatic polyester hydrolysis



Zumstein et al., *Environmental Science & Technology*, 2017, 51, 4358

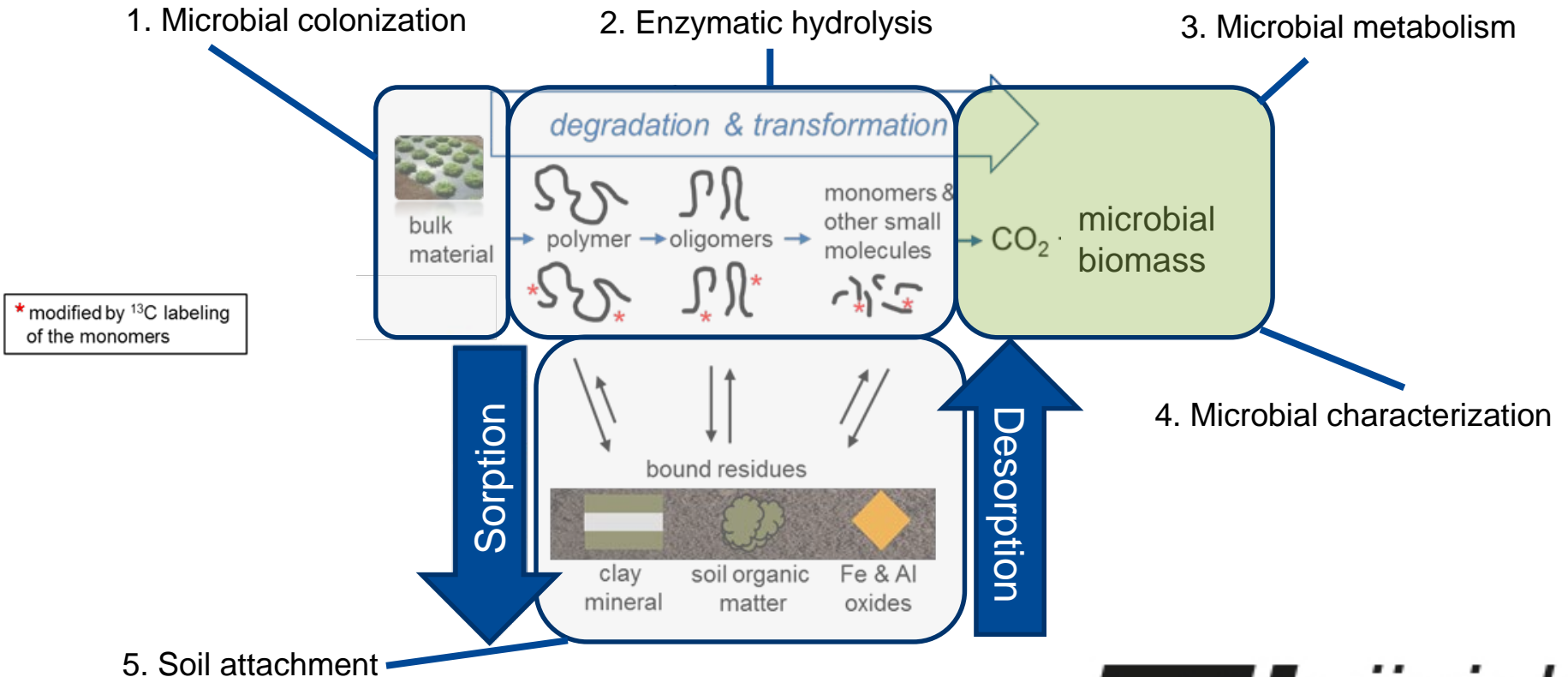


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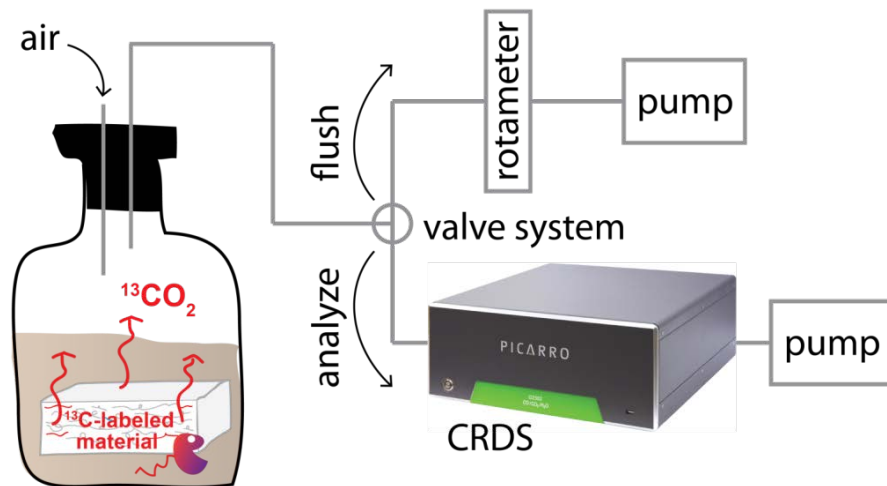
→ High throughput screening assay based on co-hydrolysis of fluorogenic ester probes embedded in polyester matrix

Decisive methods for understanding biodegradation in soil of ecovio mulch film

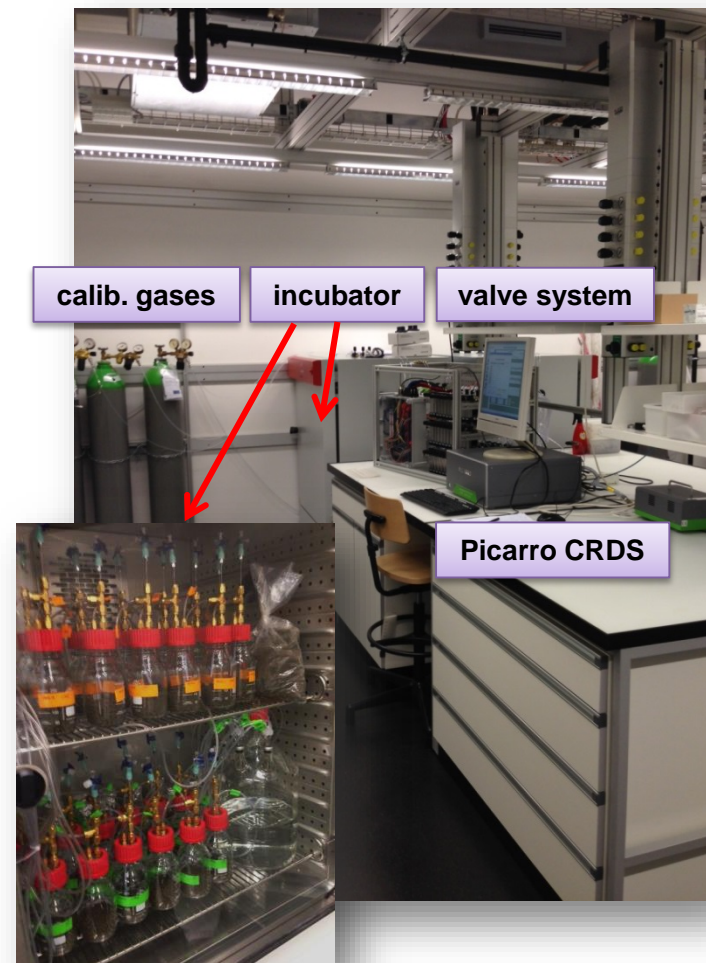
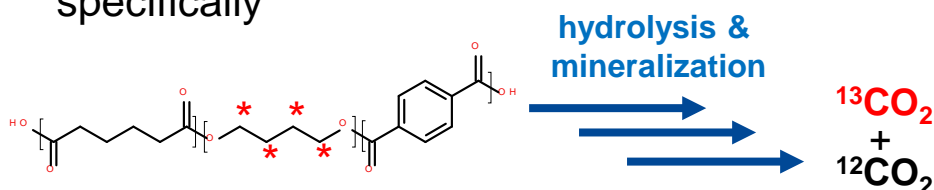


3. Microbial metabolism

CRDS technique to monitor polymer mineralization

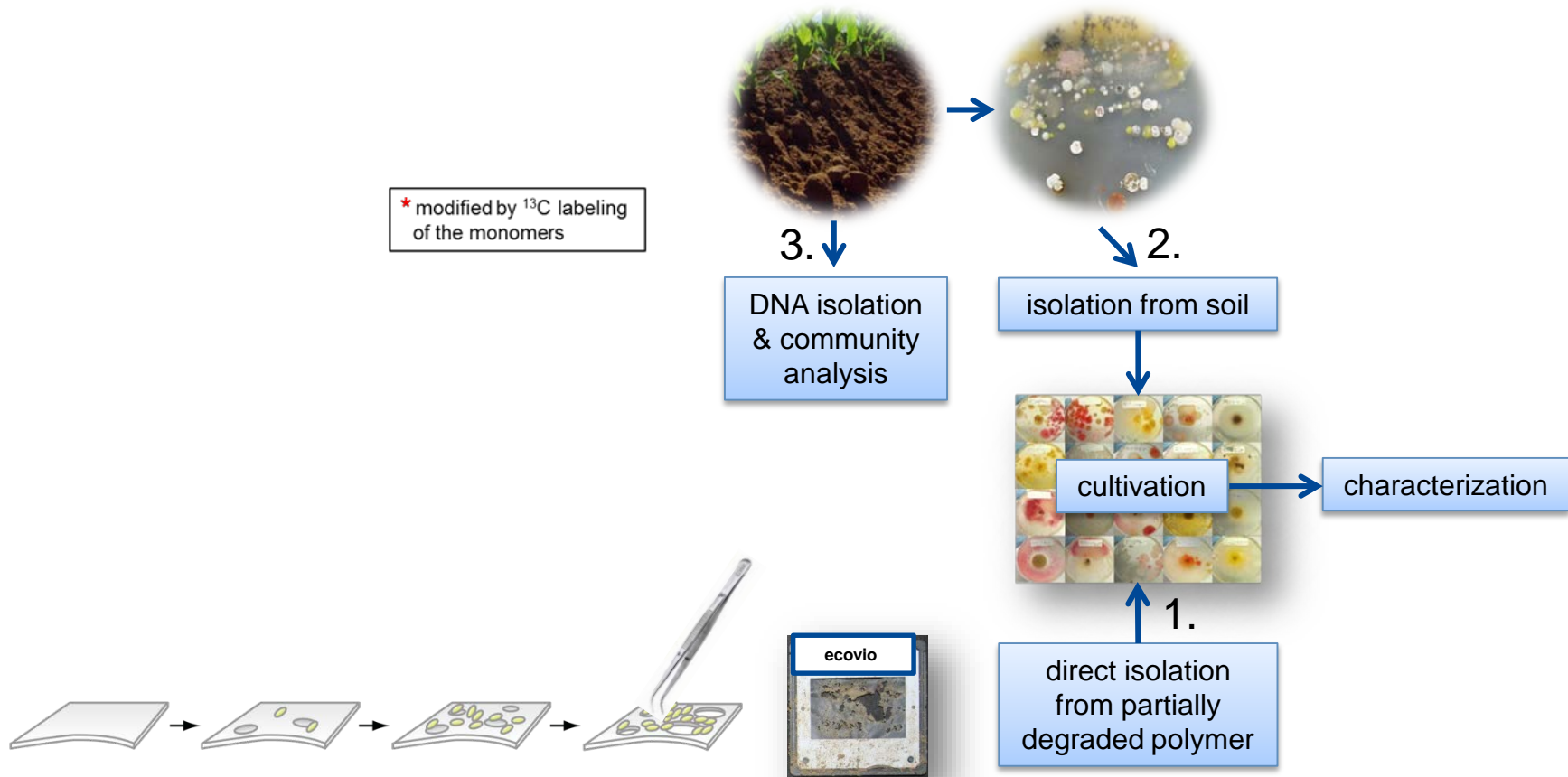


- Cavity Ring Down Spectroscopy (CRDS) method is sensitive to ^{12}C - & ^{13}C -carbon dioxide
- Mineralization of stable isotope labeled polymers can be followed very accurately & position-specifically



4. Microbial characterization

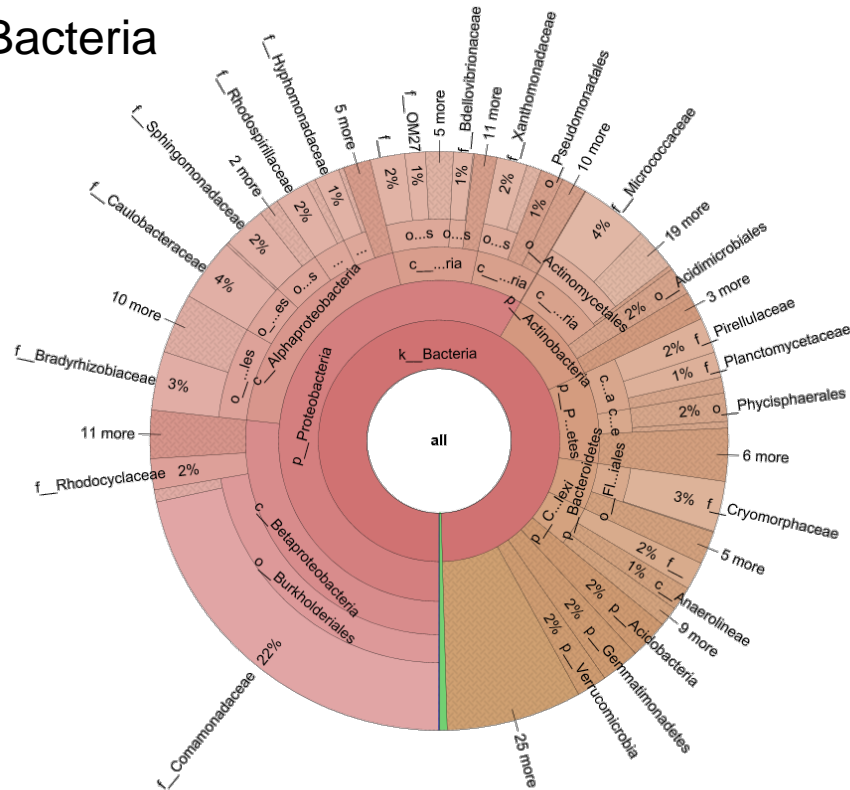
Microflora is a dominating factor



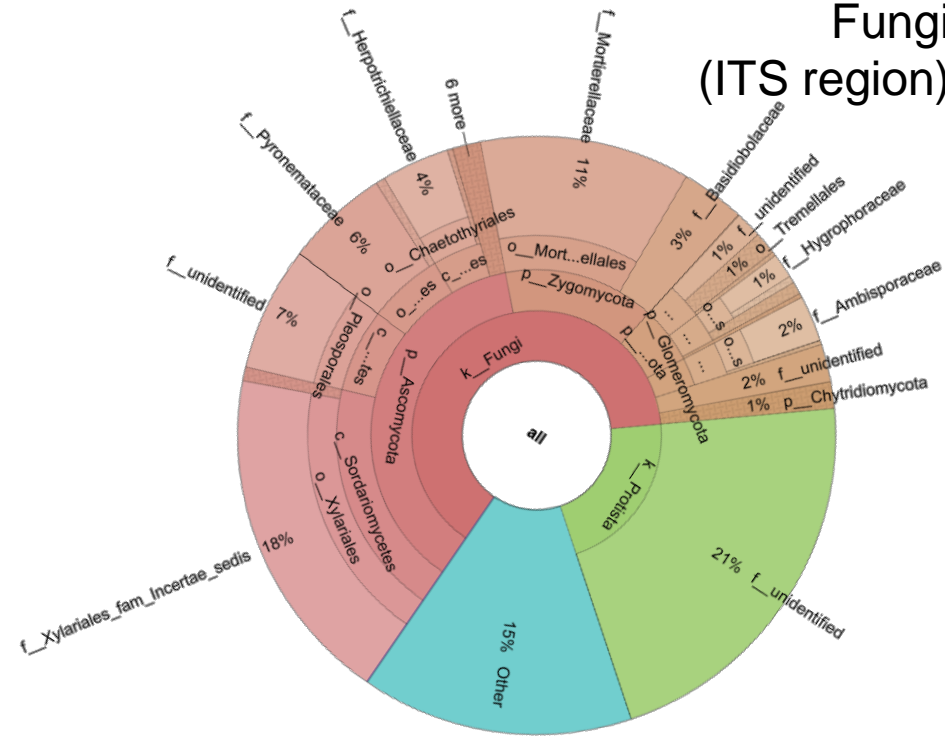
→ Strategies to isolate microbes using biodegradable polymers as substrate

4. Microbial characterization Using PBS for proof of concept

Bacteria



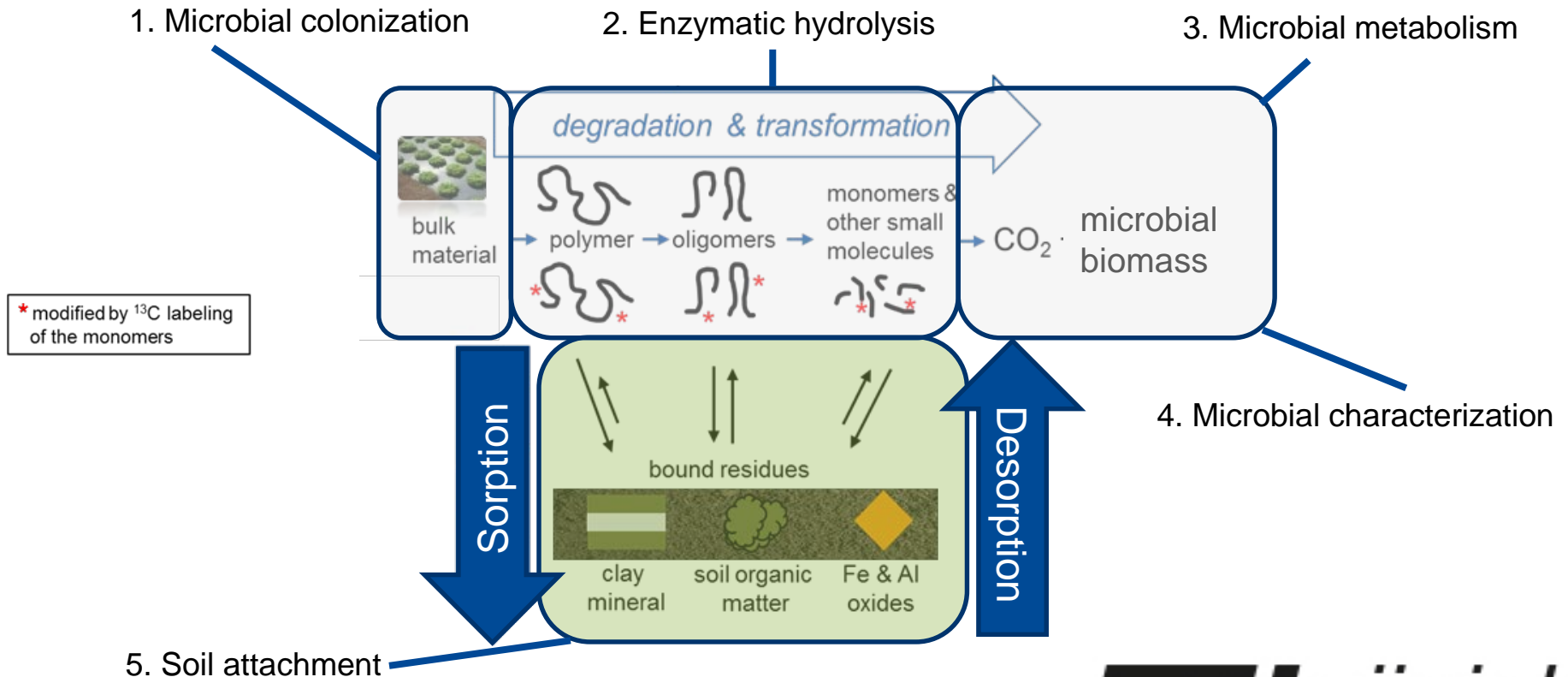
Fungi (ITS region)



PBS = poly(butylene succinate)

- Identification of a very broad variety of bacteria and fungi actively mineralizing PBS
- Active participation of full soil community in biodegradation proven

Decisive methods for understanding biodegradation in soil of ecovio mulch film



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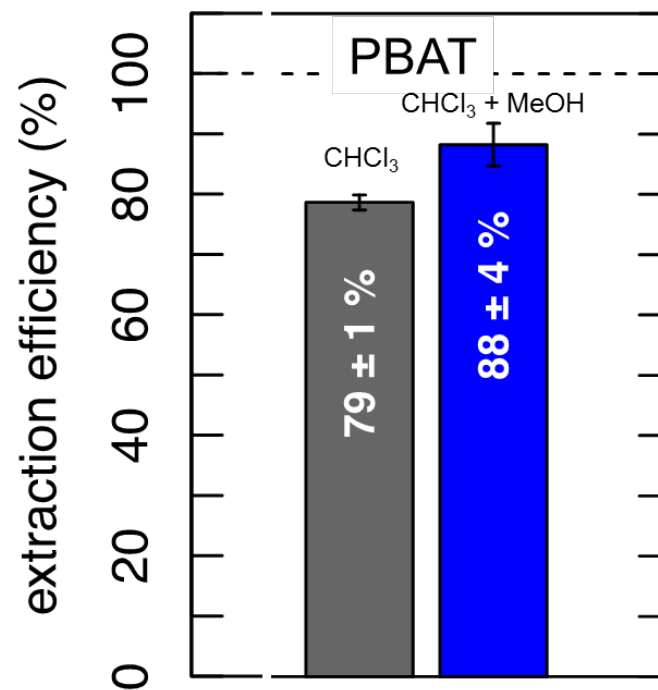
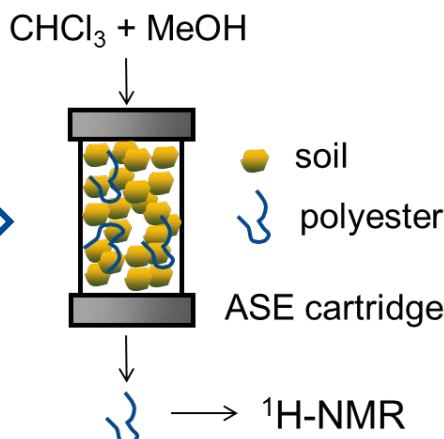
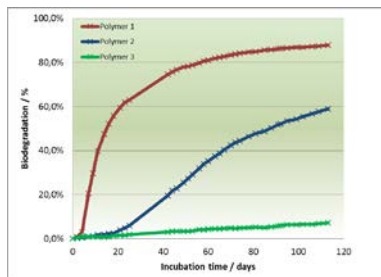
→ Where does the polymer carbon end up?

5. Soil attachment

Quantification of polymer residues in soil by accelerated solvent extraction (ASE)



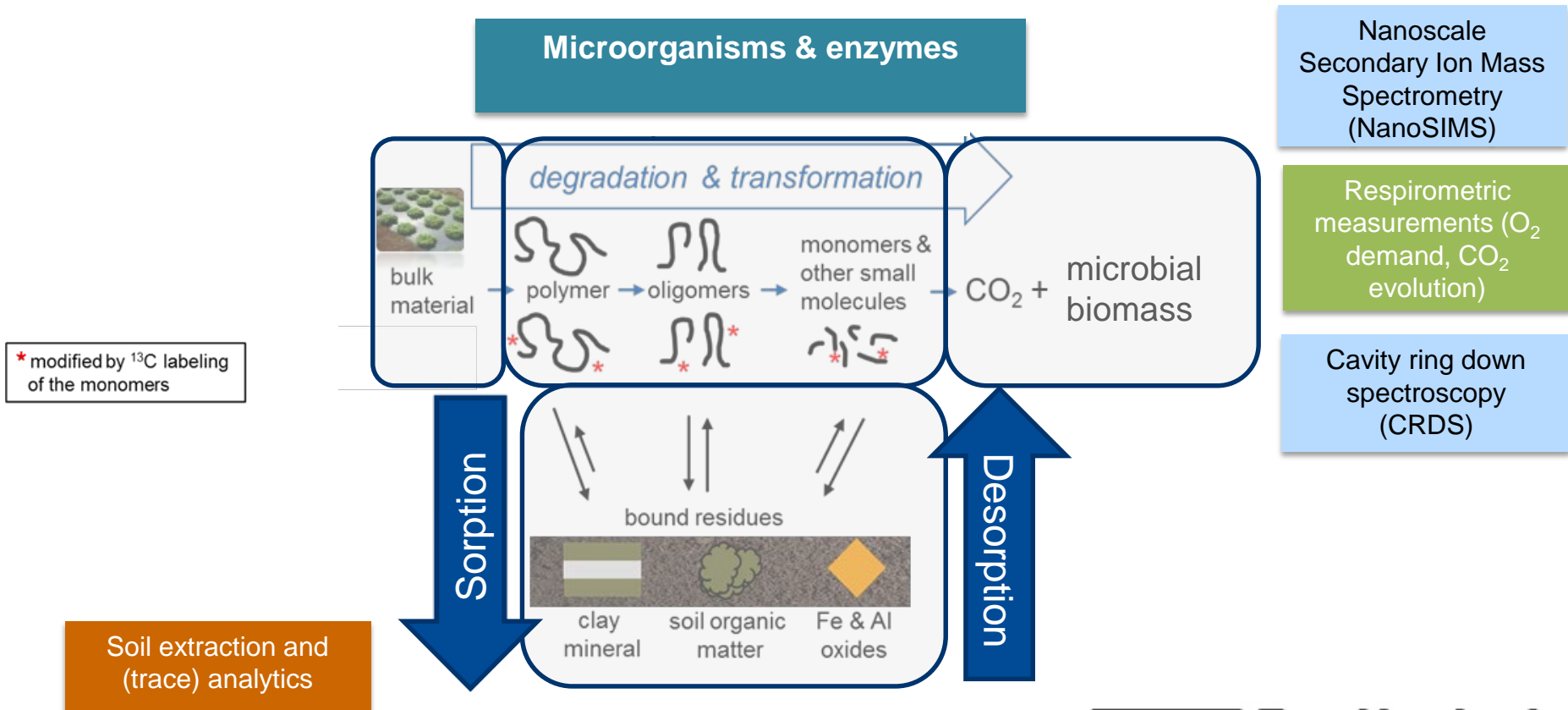
Biodegradation test



Efficient extraction of polyesters from soils

→ Method will be used for determination of polymer residues in agricultural soils and to close mass balance

Decisive methods for understanding biodegradation in soil of ecovio mulch film are established



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→ For the first time fate of polymer from biodegradable mulch film can be followed

Cooperation ETH Zürich and BASF on biodegradation in soil

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3. Advanced Materials & Systems Research – Biopolymers, BASF, Ludwigshafen, Germany

→ Landmarking cooperation for sustainable chemistry

The ongoing task for biodegradable polymers....

“Everyone needs to have the courage of conviction”

Alexander von Humboldt





We create chemistry