

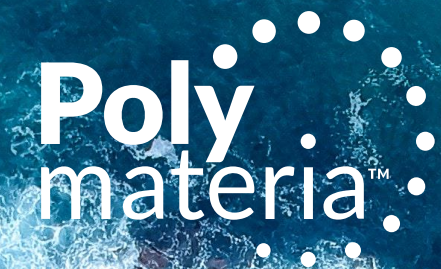


Innovation in Tackling Plastic Pollution

Dr Matthew Thornton

Chief Development Officer

Plastribution, UK - 24 February 2022



Biotransformation[®]

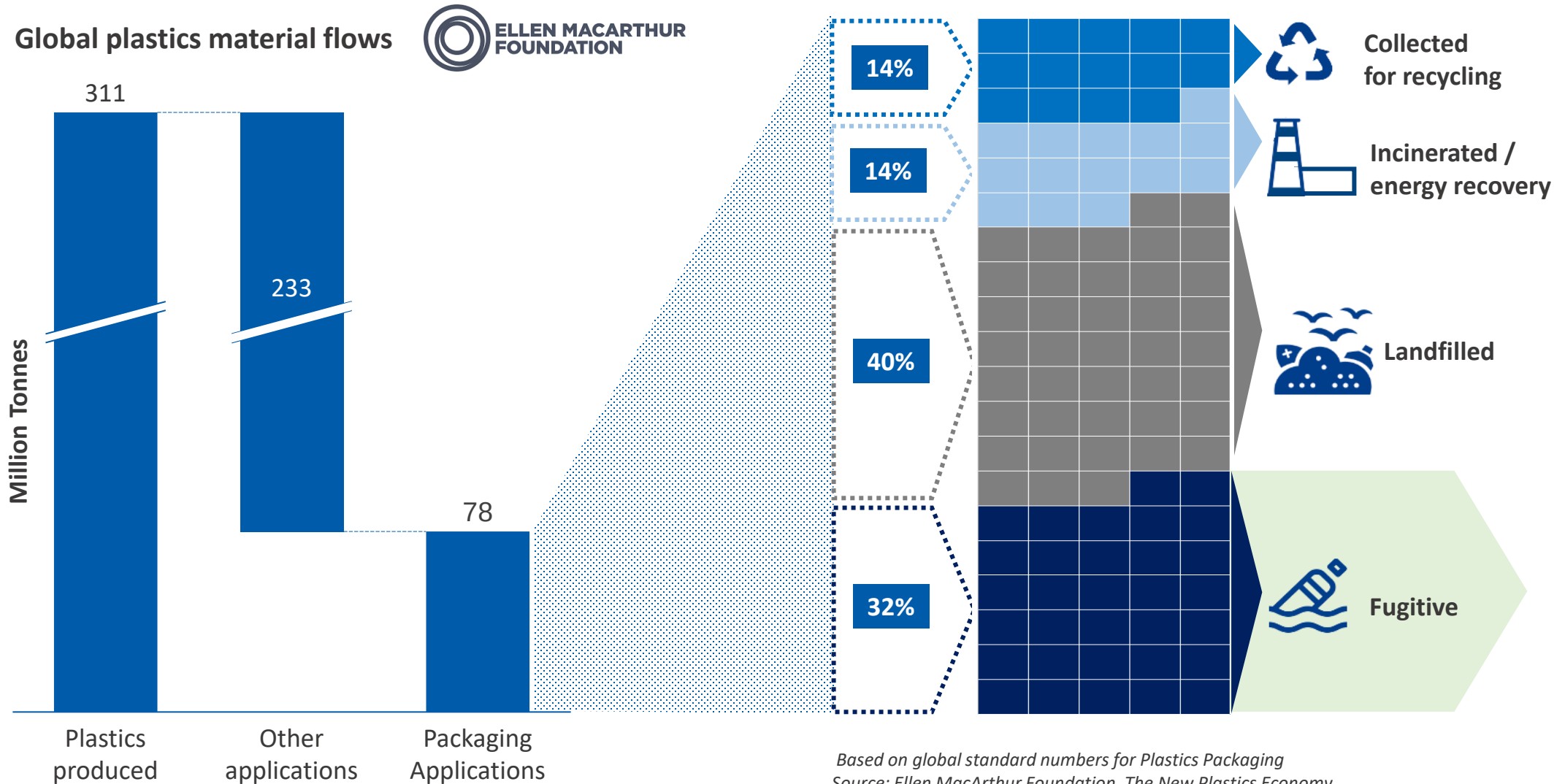
*"The world's first biodegradation technology
capable of delivering full biological decomposition
on polyolefin packaging materials in the open
environment"*

POLYMATERIA AT A GLANCE

- Advanced Tech London-scale up developing new standard in biodegradable and compostable plastics
- Emerged from the Imperial College London's Innovation Hub
- Backed by purpose-driven investment firm Planet First Partners ¹ (PFP)
- Launched the world's first biodegradation technology capable of delivering full microbial conversion on polyolefins in the open environment in 2018
- State of the art R&D facilities, London (UK) and highly specialised manufacturing plant in Lyon (France)

¹ www.planetfirst.partners

PLASTIC POLLUTION – GLOBAL MATERIAL FLOWS



OUR SOLUTION

A world's first biodegradation technology capable of delivering full biological decomposition on PP & PE materials

- Advanced catalytic system¹ able to transform PP & PE materials into a bioavailable wax which naturally occurring microorganisms can easily assimilate
- No microplastics² or toxic substances are left behind post-degradation stage
- Time controlled process to allow optimal use phase and recycling recovery, if recycling option is available
- Tested & certified to international biodegradability standard (BSI PAS 9017)³ underpinned by EN, ASTM and ISO standards (ASTM D5988/ISO 17556)
- Verified through ISO/IEC 17025 accredited independent 3rd party. Lab data cross-checked with real world conditions

¹ Proprietary technology, patent No. WO 2018/095905

² As per the European Chemical Agency's definition (ECHA)

³ BSI PAS 9017: Standard for biodegradability of Polyolefins in the open-air terrestrial environment



PAS 9017:2020

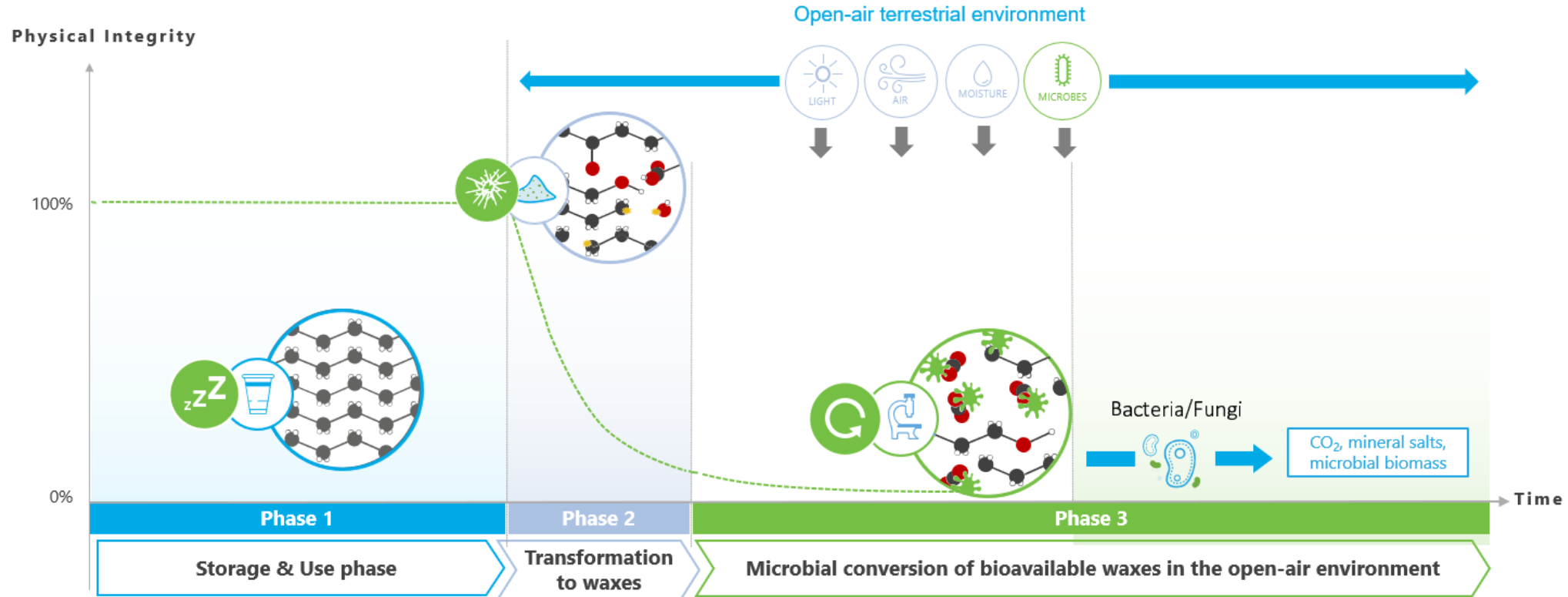
Plastics – Biodegradation of polyolefins in an open-air terrestrial environment – Specification



BSI PAS 9017

- New protocol based on pass/fail criteria enables technology to be proven against independent criteria
- Tested & certified to international biodegradability standard (BSI PAS 9017) underpinned by EN, ASTM and ISO standards (ASTM D5988/ISO 17556)
- Technology challenged against 3 different requirements:
 - Weathering and related chemical analysis to establish polymer transformation into wax
 - Ecotox testing to prove no toxic substances are present in the resulting wax
 - Full biodegradation of wax
- Verification of compliance to PAS9017 standard is released by third party independent lab
- Just over a year after it was published, the new BSI PAS 9017 standard for biodegradable plastic has already been adopted by other countries, with many more at latter stages of adoption

BIOTRANSFORMATION® IN ACTION



Phase 1:

During the use phase the technology is inactive.
The packaging behaves the same way as its non-degradable conventional counterparts.

Typical timeframe:
6-24 months

Phase 2:

If leaked into the open-air land-based environment, the prolonged exposure to various environmental stimuli will trigger a rapid chemical transformation to wax.

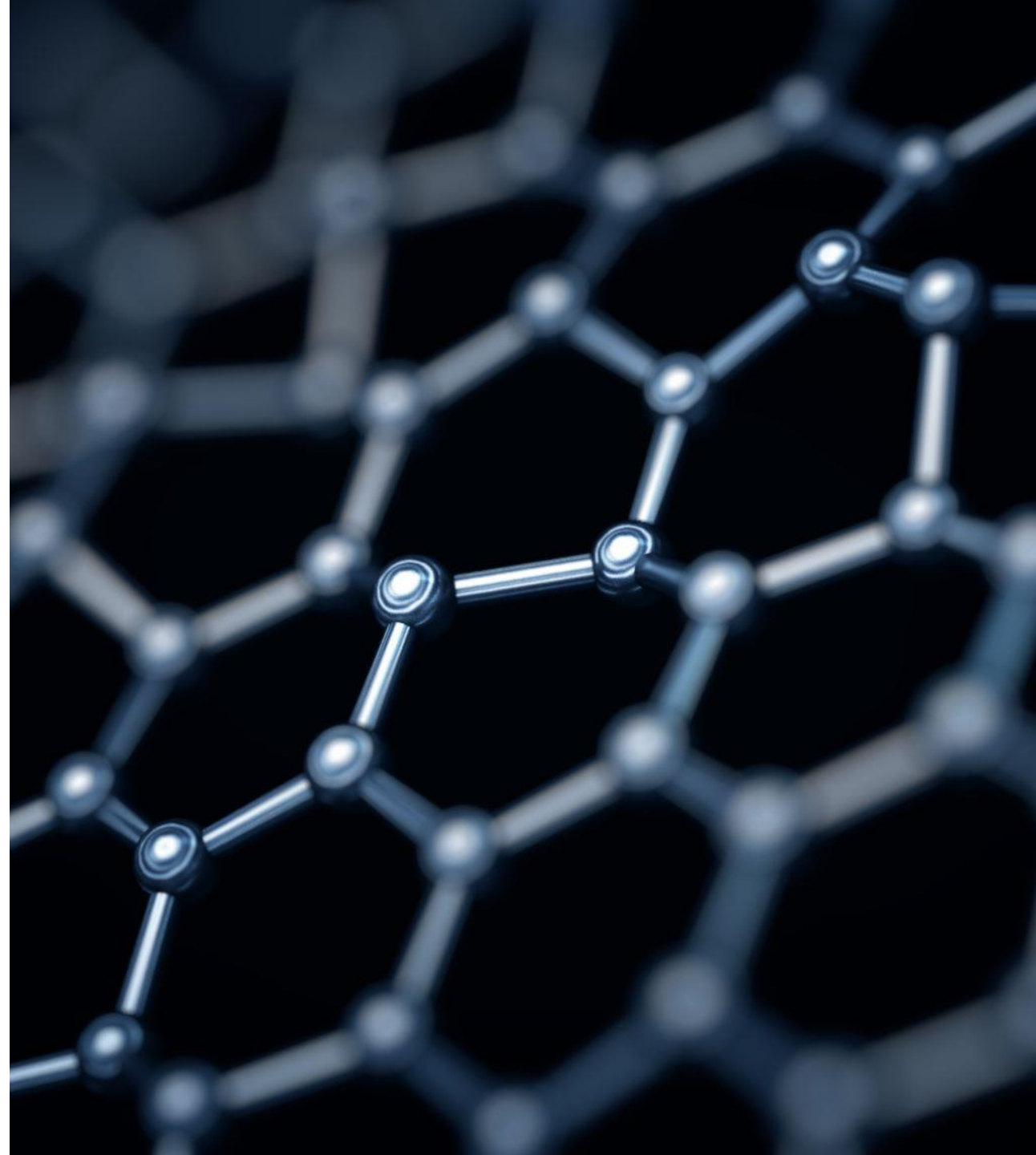
Typical timeframe:
3-5 months

Phase 3:

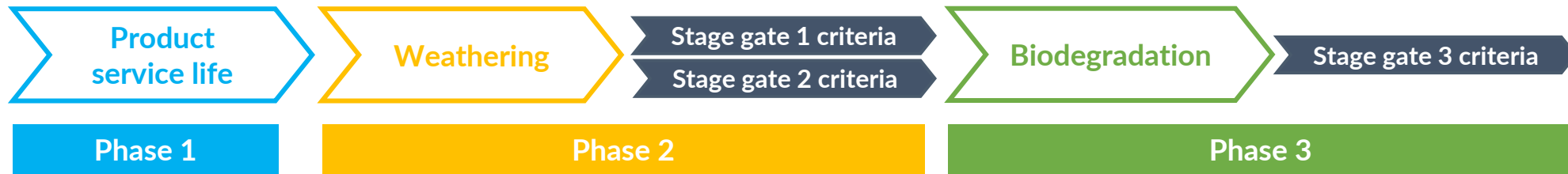
The wax is biologically converted into carbon dioxide, mineral salts and microbial biomass by naturally occurring microorganisms living on soil.

Typical timeframe:
12 months

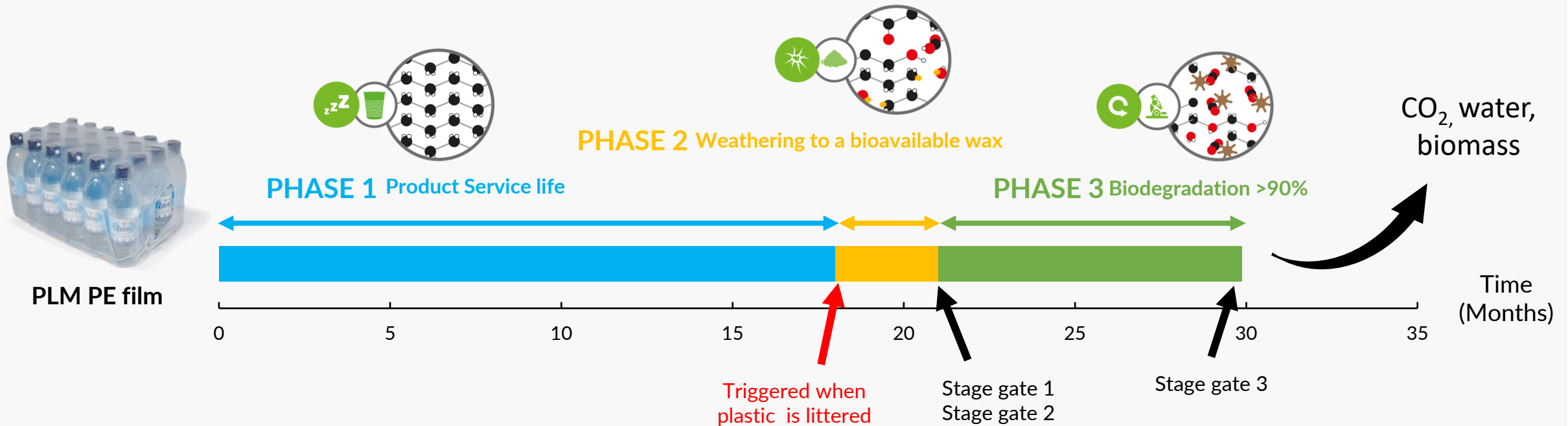
*How the Polymateria
technology innovates
within a standard
commodity plastic
product*



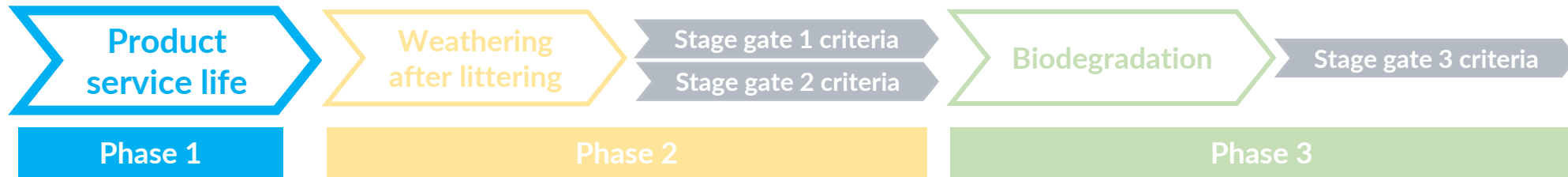
In-Depth Case Study – Biotransforming PE Film



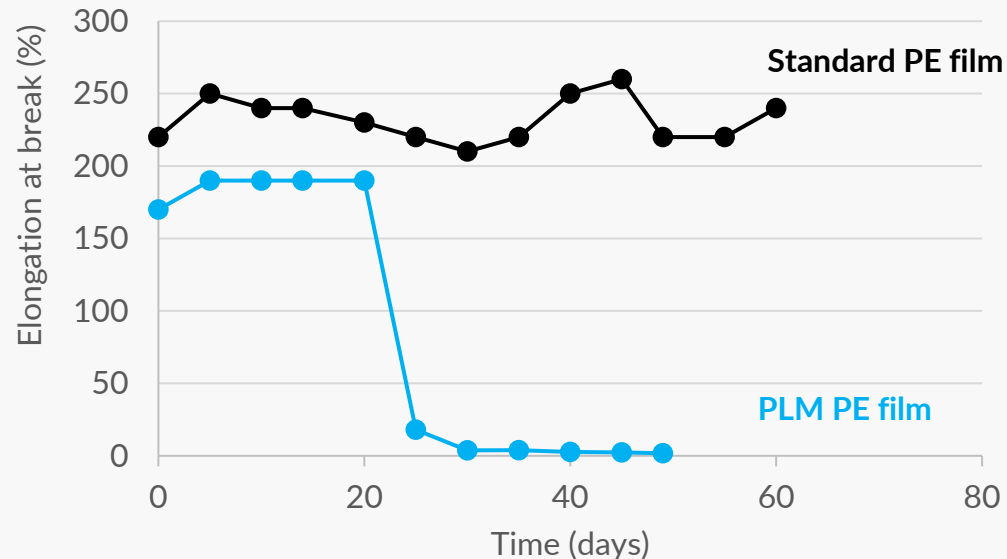
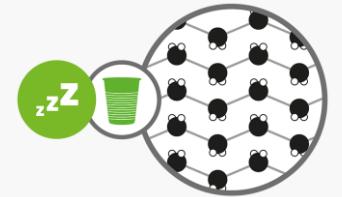
- Total lifespan



In-Depth Case Study – Biotransforming PE Film



- Product Service Life determination under ISO 2578 / ASTM D3045
 - ✓ Accelerated thermal aging
 - ✓ Measurement of loss of the mechanical properties ASTM D882-12



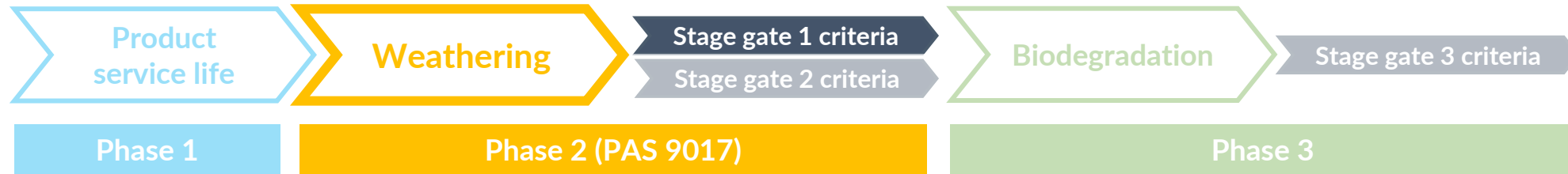
PLM service life calculator



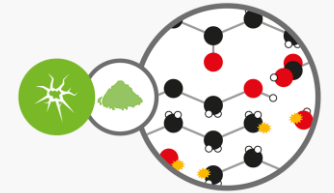
Arrhenius equation

Estimated service life = 18 months

In-Depth Case Study – Biotransforming PE Film



- Weathering: a chemical transformation to a bioavailable wax:
 - ✓ Plastic is weathered to mimic outdoor exposure if the plastic escapes into the environment, i.e. augmented version ASTM D4329 / ISO 4892-3
 - ✓ Pass/fail stage gates are used in laboratory testing at this point



Parameters	Test method	Pass/Fail criteria	Standard PE film	PLM PE film
Carbonyl Index (CI)	ATR-IR Spectroscopy ¹	> 1	0.19	1.87
Reduction in weight-average molecular weight (Mw)	ASTM D6474	> 90% initial value	0%	98.3%
Number-average molecular weight (Mn)	ASTM D6474	< 5,000 Da	13,767 Da	507 Da

✗

✓ Criteria met

¹ The carbonyl Index (CI) is measured by ATR-IR taking the A(1850-1650)/(1500-1420) as a the basis for measurement.

In-Depth Case Study – Biotransforming PE Film



- Environmental safety of bioavailable waxes:

OECD 211 (+ OECD 202)

- Water – Daphnia



- Passing OECD 211 demonstrates:
 - No heavy metals
 - No toxic compounds
 - No leachates of harmful impact to aquatic systems

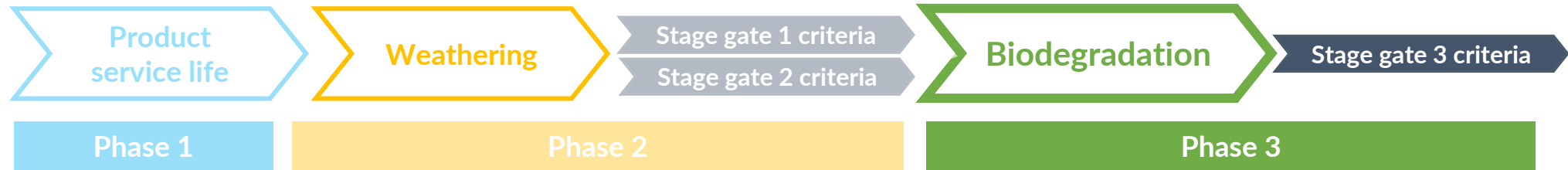
OECD 208 & OECD 222

- Terrestrial plants (seedling emergence and growth)
- Earthworm reproduction

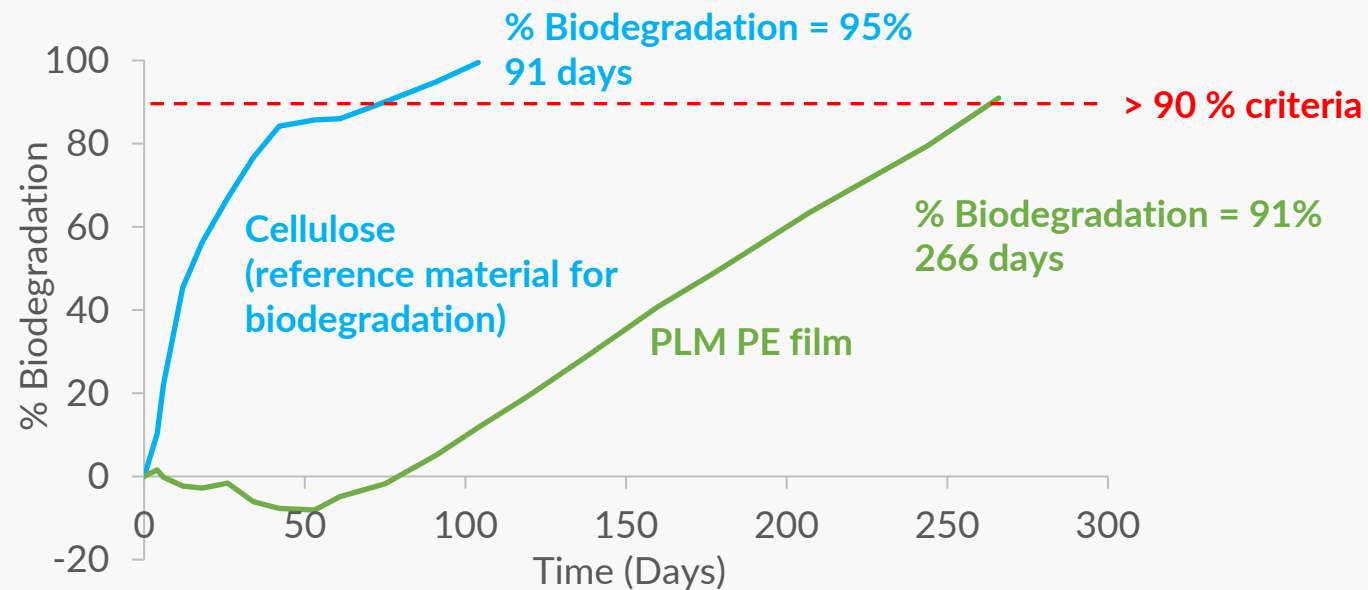
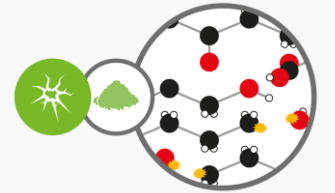


- Passing OECD 208,& 222 demonstrates:
 - No chronic harmful effects due to longer term exposure in soil.

In-Depth Case Study – Biotransforming PE Film



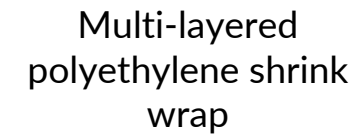
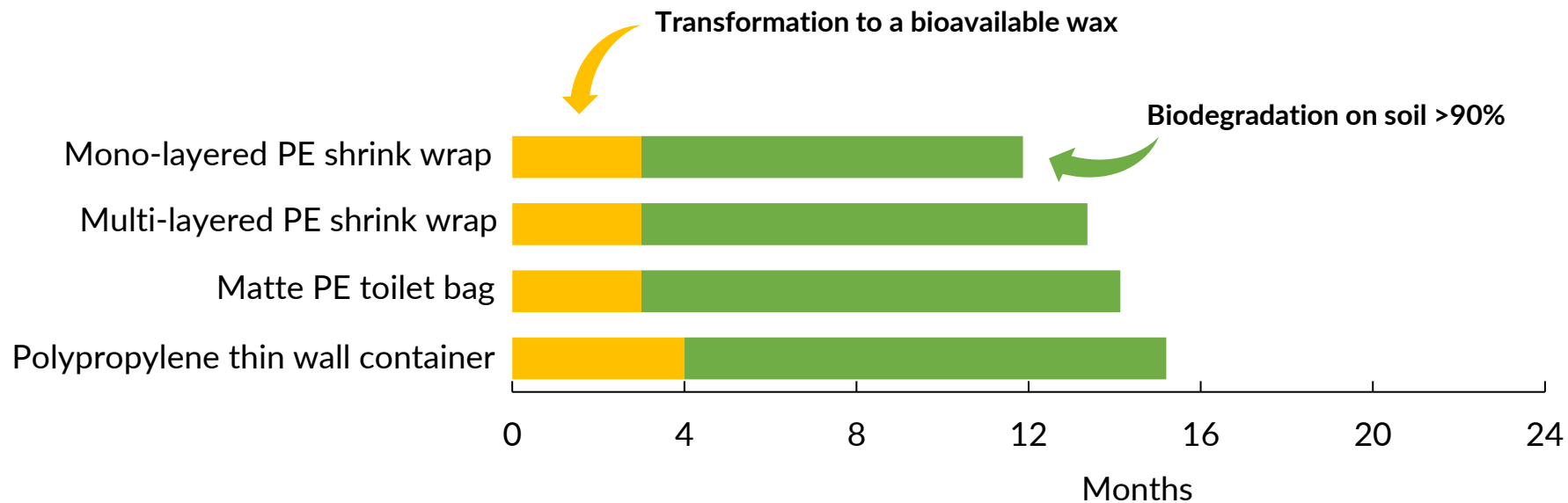
- Biodegradation on soil under mesophilic conditions:
 - ✓ After weathering, biodegradation on soil launched under ISO 17556 / ASTM D5998



Evidence of Varied Plastic Packaging Biotransforming

- Pass/Fail criteria for a bioavailable wax:

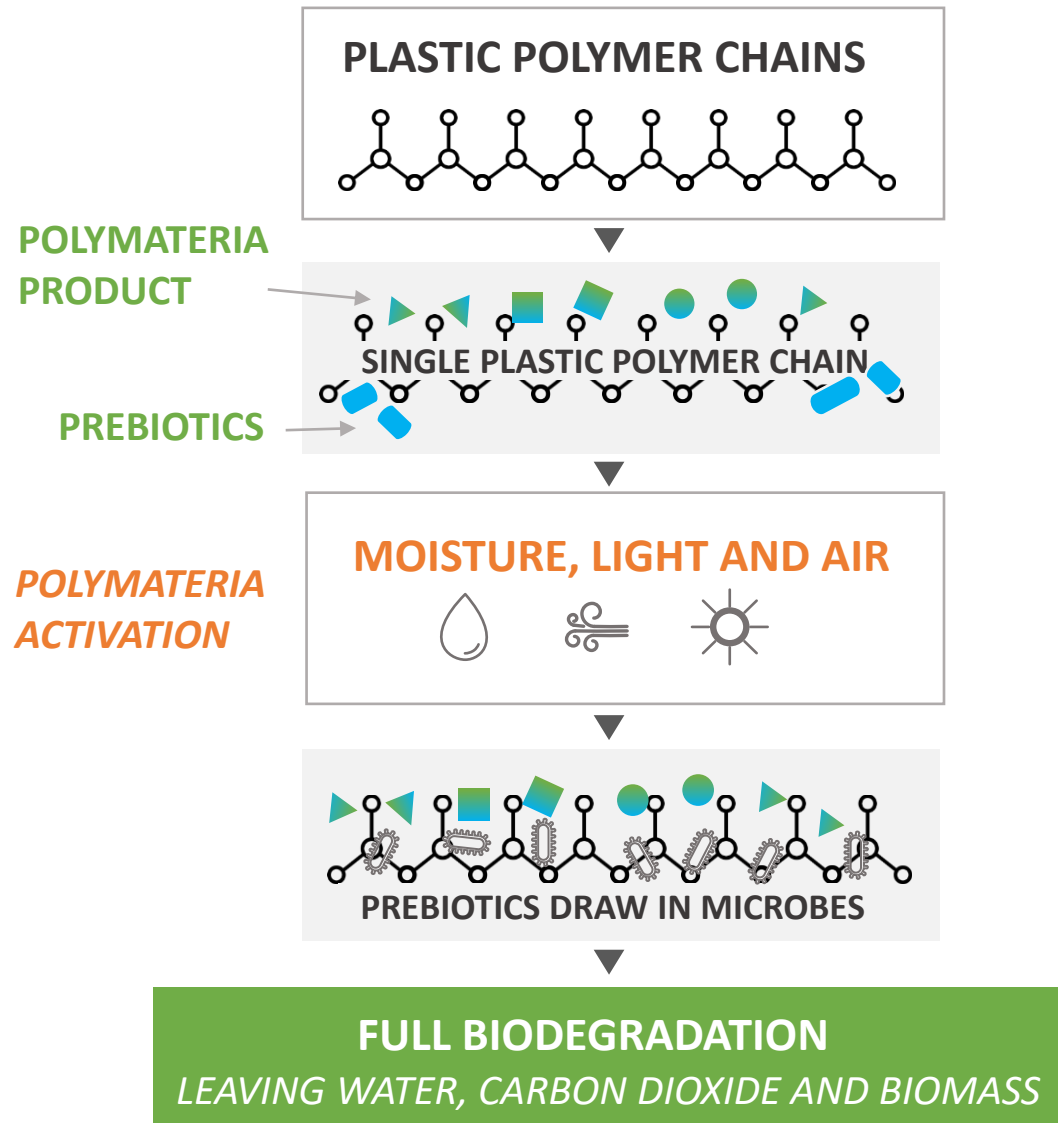
- ✓ Carbonyl Index (CI) > 1
- ✓ Reduction in weight-average molecular weight (Mw) > 90%
- ✓ Number-average molecular weight (Mn) < 5,000 Da
- ✓ Higher weight average molecular weight (Mz) < 30,000 Da



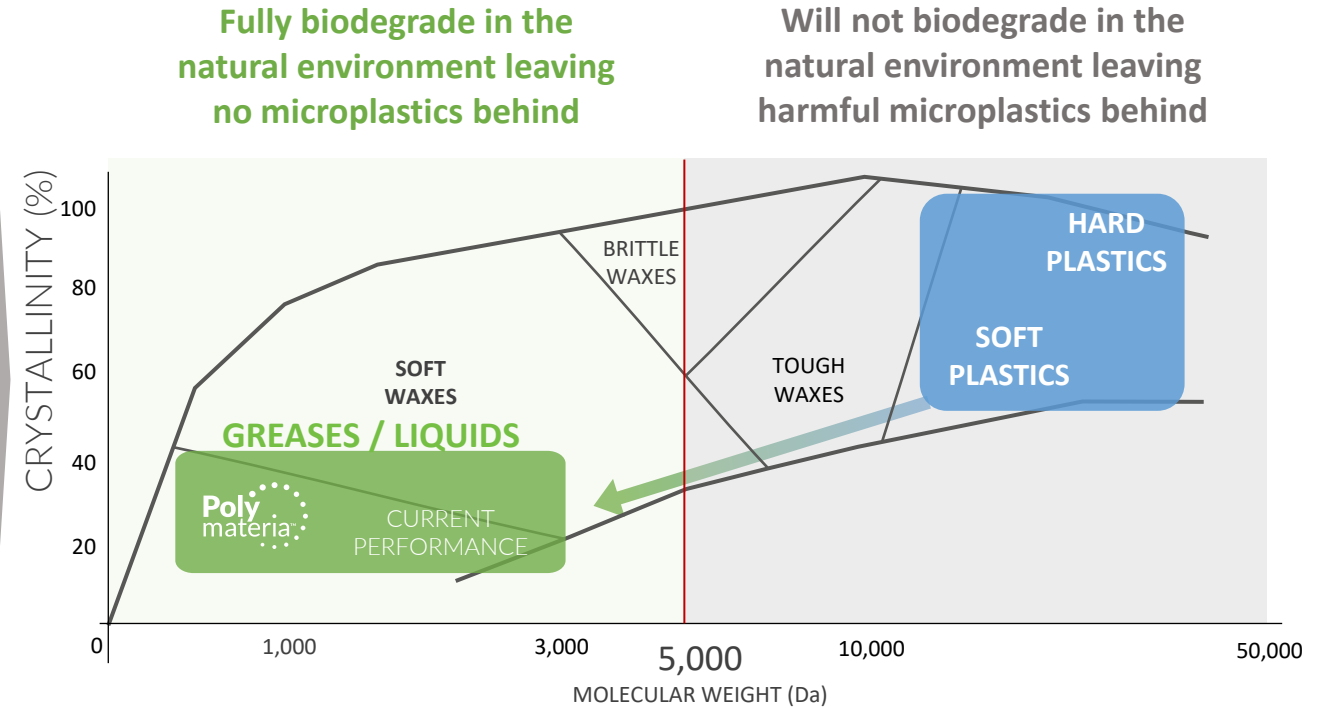
*How the technology
works*



FULL BIODEGRADATION WITH NO MICROPLASTICS LEFT BEHIND



UNIQUE CHEMICAL TRANSFORMATION TO BIOAVAILABLE WAX



Degree of molecular transformation controlled through stringent specifications on achieved molecular size reduction (Mw, Mn, Mz)
→ ensure no microplastics are left behind

HOW IT IS DEPLOYED

- Formulated as a drop-in Masterbatch (MB)
- Each MB is tailored to the resin's footprint, application profile and required use life
- Compatible with the normal plastic conversion processes which limits cost
- No impact to product performance or functional benefits
- Allow for recycling to happen through time-controlled process
- Typical loading rate: 2 wt.%





Find out more at
www.polymateria.com

Contact: mt@polymateria.com

