Achieve Healthcare product circularity

-with data-based evidence of no change in regulatory status

Anja Gottschalk
Healthcare Applicaiton Development Engineer

Borealis AG

Introducing Borealis

Borealis at a glance

Worldwide

Head Office in **Vienna**, Austria.
Operating on **five continents**
in **120 countries**

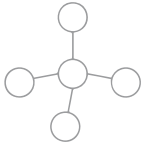
Market Position

#2 among polyolefin
producers in **Europe**
#8 worldwide

Employees

About
6,900 employees

Line of Business



Production and distribution of
polyolefins, **base chemicals**
and **fertilizers**

Ownership Structure

75% OMV, Austria /
25% Mubadala, United Arab
Emirates

Financial figures

Net profit 2021 – **1,396** MEUR
Total sales 2021 – **12,342** MEUR

Joint Venture

Borouge – one of the world's
largest integrated polyolefin
complexes (Ruwais, UAE)

Joint Venture

Bayport Polymers – brings
Borstar® technology to American
polyethylene markets

Circularity

Two **polyolefin recycling**
operations in Europe

Patents

133 priority patents
filed in 2021,
#1 in Austria

Medical Grade Plastic

Bormed™: Borealis portfolio of medical grade PE and PP

Commitment

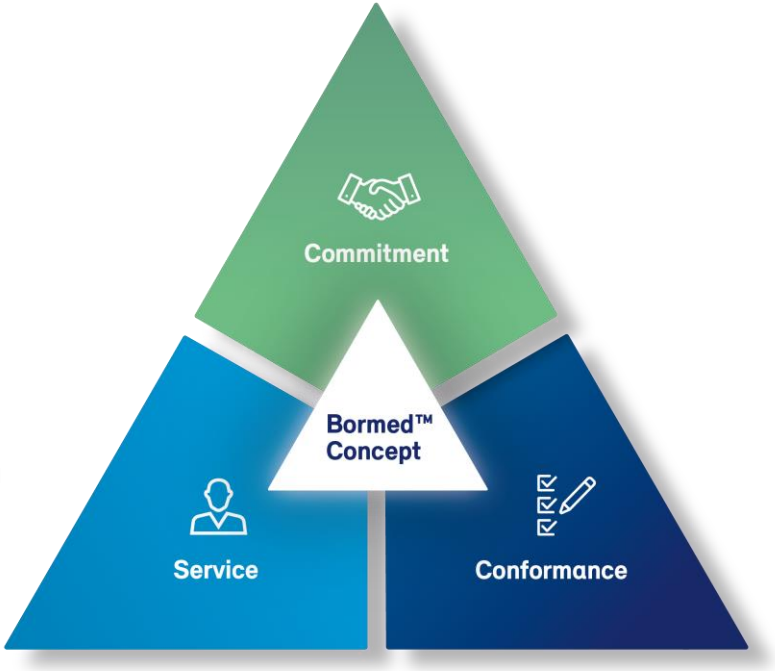
- Consistency of product recipe via rigorous change control procedure
- Continuity of supply regulated by Technical Delivery Specification
  - Product made available up to 5 years (2 years pre-notification and a last call volume combined with 3-year shelf life)
- Bormed Directive (PO-4047): internal operating instructions for the development, production, storage and delivery of Bormed grades

Conformance

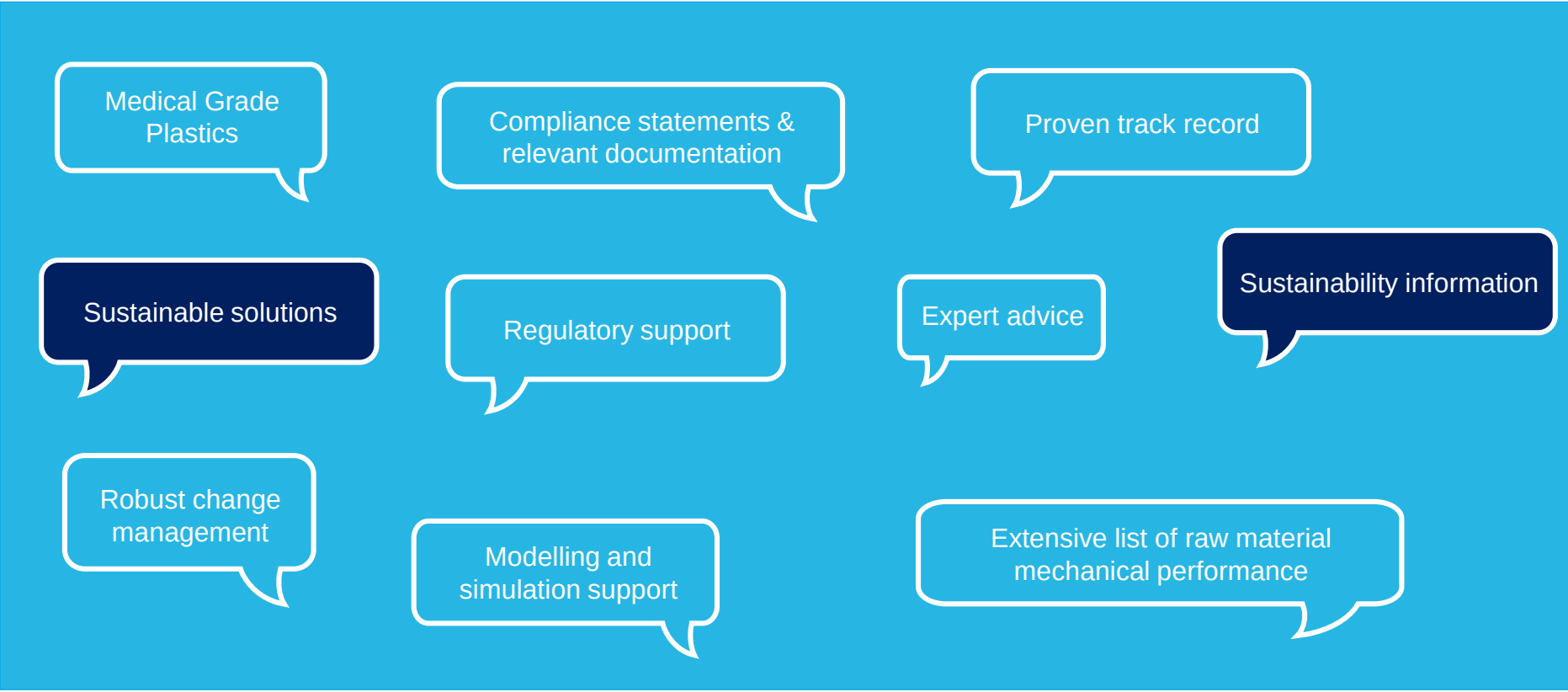
- Pharmacopeia compliance
  - External Ph. Eur., USP (incl. 661.1) and ISO 10993 testing: analysis reports can be shared on request; DMF listing; following VDI guidelines on MGP

Service

- Extractable profiles / recipe disclosure: shared on request under NDA
- Globally available dedicated team of experienced technical and regulatory specialists



What material and design engineers told us…a wish list



How?

Borealis is fully committed to closing the loop

Accelerating the transition to a circular economy by addressing DfR, plastic waste and climate change

Design for Recycling

Design for Recycling

- Eco-efficient design so that healthcare applications can be collected, sorted and recycled (e.g. “mono” material)
- Example: substitution of PVC/Al blister materials with 100% PP solution

Borcycle™ C

Chemical recycling

- Plastic Neutrality
- Value: fight plastic waste; meet recycling targets
- Virgin equivalent, food approved and medical grade (Bormed)
- ISCC+ certified mass balance

The Bornewables™

Renewable-based (2nd gen.) POs

- Carbon Neutrality
- Value: reduce carbon footprint by at least 120%; fossil depletion by ~70%*
- Virgin equivalent, food approved and medical grade (Bormed)
- ISCC+ certified mass balance

Commercially available solutions for Healthcare

*vs. fossil-based in terms of GWP and abiotic resource depletion / LCA based on ISO14040, ISO14044, ISO14067 critically reviewed by third party panel

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The Bornewables ™ : Offering virgin quality and a significant reduction in CO_2

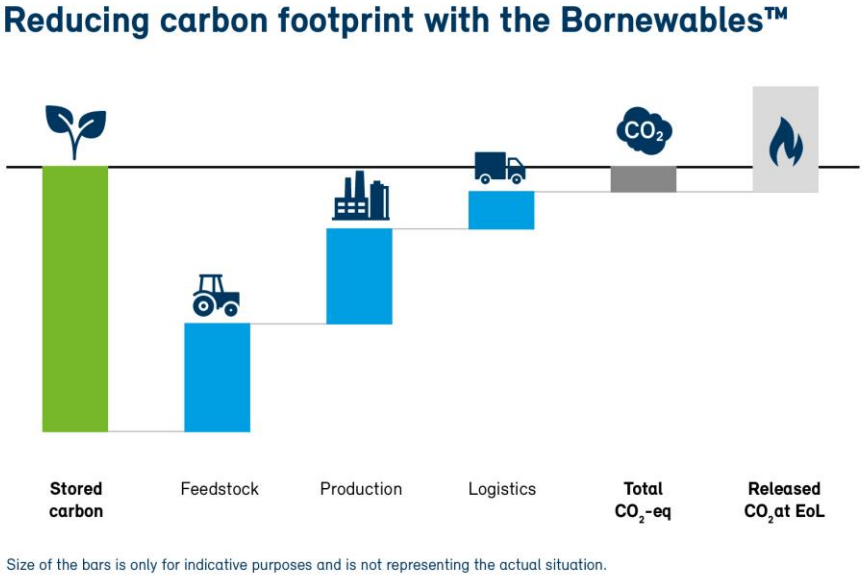
Making the right choices

2nd generation

Renewable feedstock not suitable for consumption (non-food crops, waste)

Such as:

- Waste and residues from vegetable oil refining
- Used cooking oil (UCO) collected from food industry and restaurants



Comparison of CO2-footprint reduction

When replacing 1 tonne of conventional PP with Bornewables™ PP you save 2.1 ton of CO2 -eq.

This is comparable to CO_2 emission of:

3 Return-flights from London to Beijing[1]

20 people trying vegetarian for a month[4]

95% of average European household's annual energy usage[3]

driving **17.000km** with new car in EU[2]

Charging **2100** smart phones for a year[5]

1. 1404kgCO_2/journey 2. Average emissions of new cars registered in 2019 in the EU28 = 122.4 gCO_2/km 3. Electricity, Gas etc (2019, EU-27) per person: 726 kg/jr, 3.1 p./h.h. 4. Meat-lover = 7.2 kgCO2/day; vegetarian = 3.8 kgCO2/day 5. Charging for 2hrs at 6W in EU (2018) at ~230grCO_2/kWh

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Chemical recycling, a part of the solution for closing the loop

Renews plastic back to plastic

The solution for high purity, high performance materials

- Borcycle™ C is our portfolio of **transformational chemical recycling solutions**, giving polyolefin-based, post-consumer waste another life.
- It offers all-round benefits, supercharging the transition to a circular polyolefin industry whilst creating **virgin quality plastic products.**
- A solution creating both virgin-level grade materials and high safety and performance qualities fit for demanding applications.
- Borcycle C renews plastic back to plastic; creating recycled materials with a level of purity fit for protective, food-safe and other demanding applications.

Borcycle™ C in action

Advancing the introduction of Borcycle™ C wih several project and collaborations

Borealis collaborates in OMV´s Patented Chemical Recycling Technology

- Fully integrated into the OMV´s Austria refinery
- Current (pilot) plant has a capacity of up to 100kg per hour

Renasci to exclusively supply Borealis with chemically recycled output material

- Projected output 20kT/year from their high-tech recycling centre

New chemical recycling unit in Stenungsund, Sweden expected to commence operations in 2024

- Feasibility study underway for chemical recycling plant in Sweden (2024)

Bornewables™ Data based evidence on equivalency

Following the renewable/fossil feedstock through the value chain (1/2)

Oil and gas production

Polyolefins traditionally begin with **oil and natural gas** (~4% becomes plastic raw material)

Refining (fossil-based)

The oil and gas mixture is separated into different products by distillation to produce **fossil-based hydrocarbons**

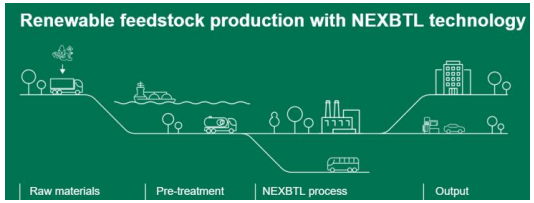
The cracking process

Hydrocarbon molecules are modified into new molecules, including the gases **ethylene and propylene** (the monomers of polyolefins)

Renewable (2nd gen.) production

Collection of **used cooking oil** and **waste and residue streams** from vegetable oil refining

Refining (renewable-based)*



Renewable raw materials are pre-treated, then hydro-treated (NEXBTL technology) to produce **renewable-based hydrocarbons**

*Source: Neste

Following the renewable/fossil feedstock through the value chain (2/2)

The polymerisation process

Polymerisation is a chemical reaction caused by a catalyst (for PP and HDPE) where monomer purity is key for a continuous process in this closed environment

PE and PP

Bormed™ PE and PP polymers: dedicated to the healthcare industry and delivered to converters / CDMOs, usually as 2-to-3-millimetre particles (pellets)

Healthcare solution

Borealis' customers melt Bormed PP and PE and process them into the end healthcare application

Tests evaluating the bio-propylene to the standard propylene measurement

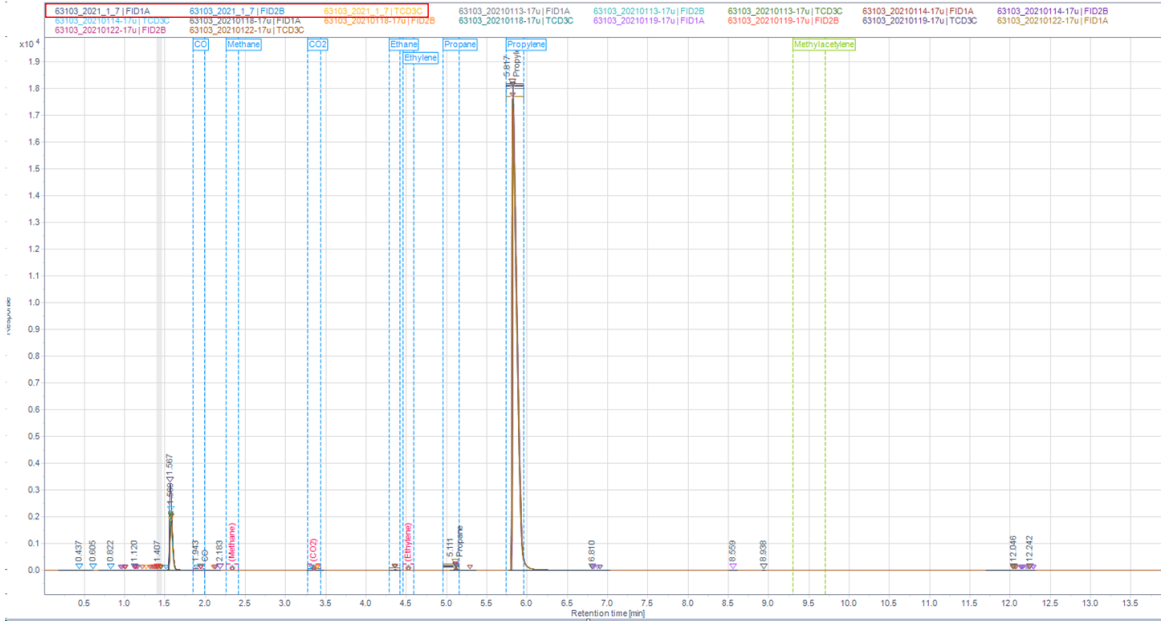
Bio-propylene used to polymerise into the Bornewables™ portfolio

- No differences in peaks: neither amounts nor heights
- Main component is propylene

NO CHANGE in monomer purity and specification

Gas chromatograms of monomer

Fossil vs renewable-based feedstock, before entering polymerisation process



The Bornewables™ : Controlled blending trial

To create data-based evidence of no change in regulatory status

What, How and Why?

- Renewable-based monomer was controlled blended to produce:
  - PP with 46% physically present and certified renewable-based content (externally tested by Beta Analytic via C14 analysis)
- Reference: same PP grade made by fossil-based monomer

Purpose:

- Gather data and evidence of no change also on output material

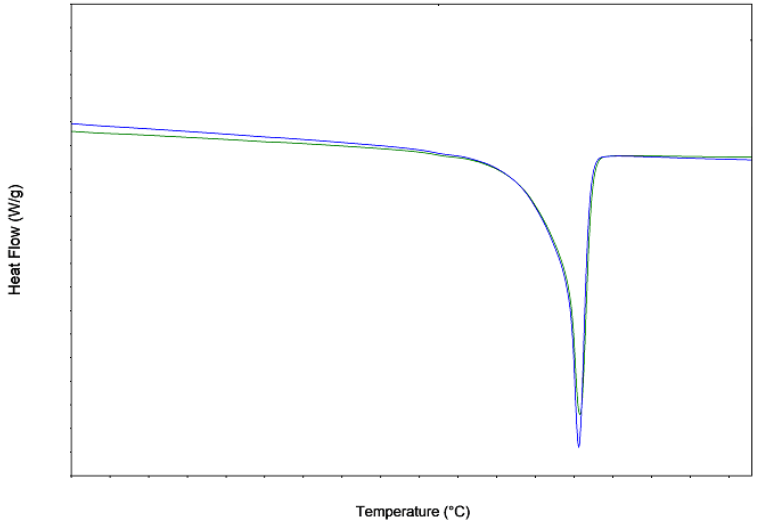
Polymer Design, Food Contact & Mechanical Properties remain in the range of lot-to-lot variation

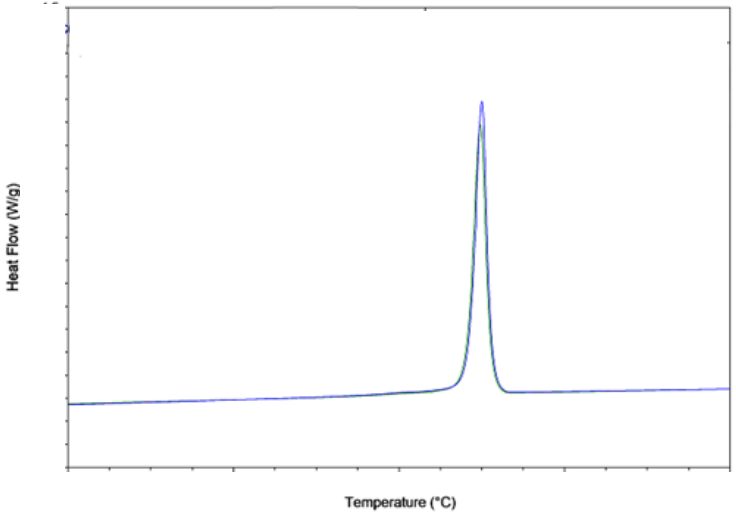
			Fossil reference	46% Bornewables
C6 solubles film (FDA)*	Weight fraction	wt%	2,95	2,81
HDT (ISO 75-2), B 0.45MPa	Tm	°C	87	87
Tensile properties (ISO 527-1,-2) 1A +23°C >96 hr	Tensile modulus	MPa	1411	1380
	Tensile strain at yield	%	5,0	5,3
	Tensile strength	MPa	26	26
	Tensile stress at break	MPa	16	16
Charpy notched (ISO 179-1), + 23°C >96 hr	Impact strength	kJ/m2	5,1	5,1
Charpy notched (ISO 179-1), - 20°C >96 hr	Impact strength	kJ/m2	2,9	3,0

*Food contact requirement: < 5.5 wt%

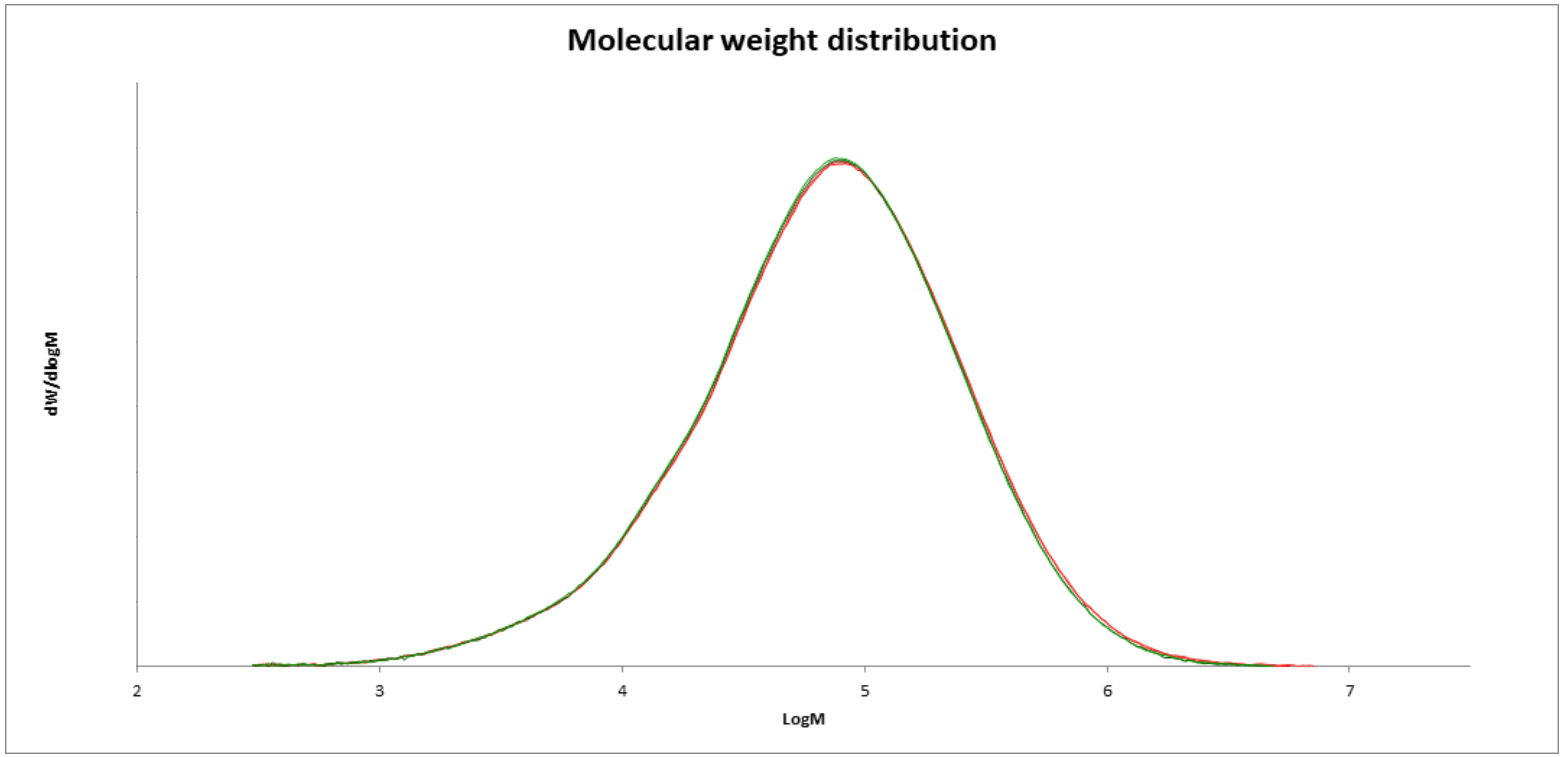
DSC: No change in crystallisation and melting temperature meaning no change in processing and sterilisation behaviour

			Fossil reference	46% Bornewables
DSC	Tcr	°C	125	125
	Tm	°C	164	164



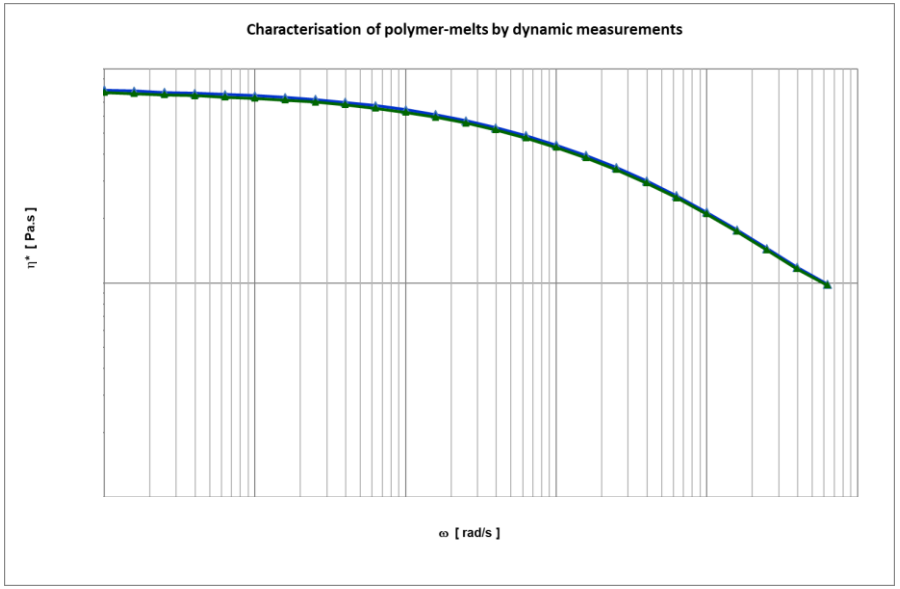


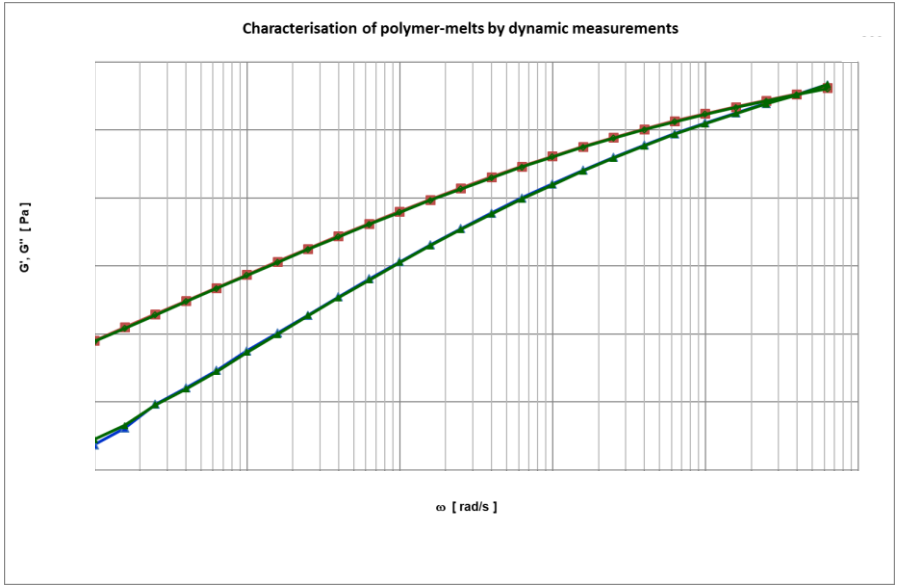
No change in MWD meaning no change in material performance/characeristics (processing,shrinkage,dimensional stability)



No change in rheology meaning no change in processing (flow behaviour, polymer design)

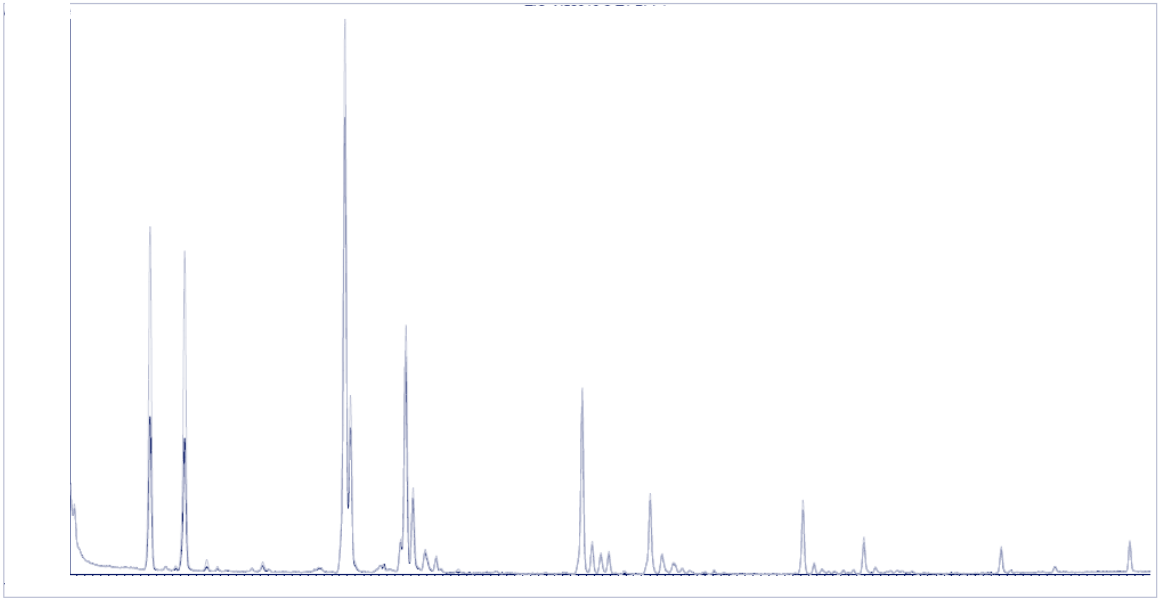
Frequency sweep @ 200°C





No change in HS-GC/MS meaning same emission fingerprint of material

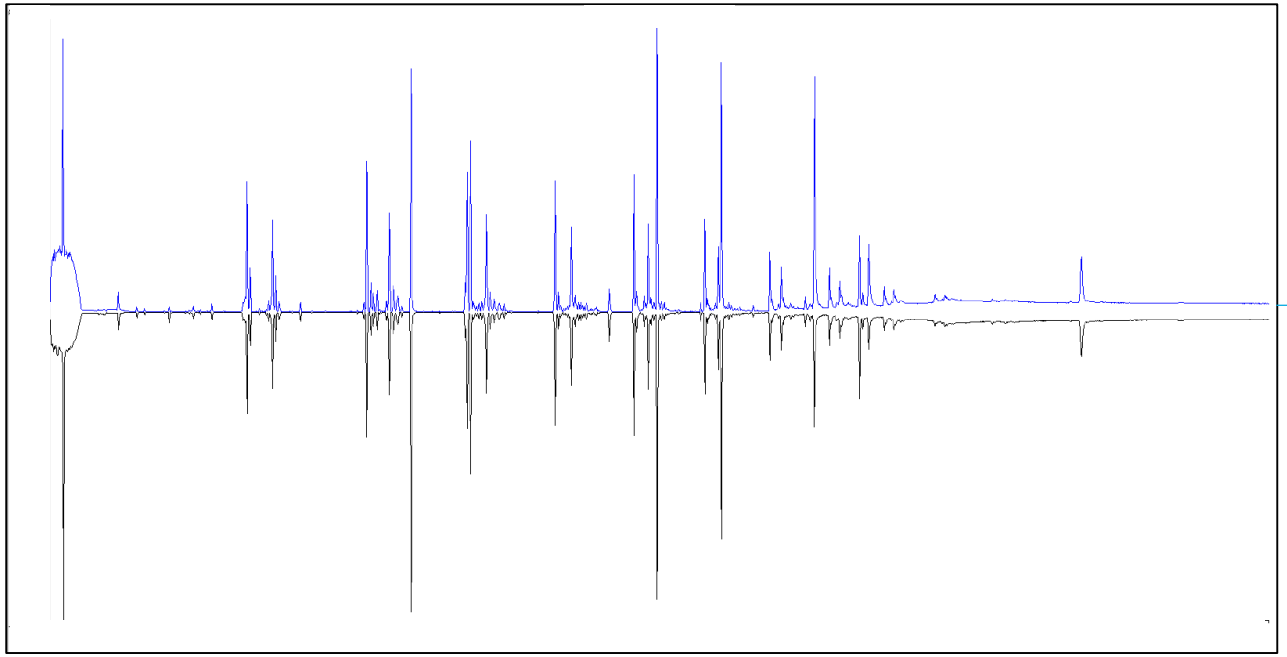
HS – GC/MS



HS-GC/MS confirms no differences in peaks between 46% Bornewables and fossil-based reference

Extractable results in Ethanol confirm no change in chemical fingerprint

GC/MS analysis for semi-volatiles in the EtOH closed vessel extract



Fossil reference

46% Bornewables

Summary

The Bornewables ™: Achieve Healthcare product circularity

With no change in regulatory status

Conclusion

– Presence of nearly 50% carbon from renewable source **has no impact on**:
  – Polymer chain stereoregularity and isotacticity
  – Polymer design
  – Polymer properties (micro/macro)

Meaning **NO CHANGE** in:

  – Regulatory status
  – Biocompatibility
  – US FDA DMF listing

The Bornewables ™ line of Bormed ™

No change in regulatory status and no compromise on patient safety

- Healthcare's carbon footprint is 4.4% of global net emissions (2 gigatons of CO_2 eq.)*
- **Environmentally sustainable** Bormed alternatives **available now** with:
  - **Reduced carbon footprint** by at least **120%** vs. fossil
  - **No change** in quality, purity, processing, specifications
  - **No change** in biocompatibility
  - **No compromise** on patient safety

Bornewables™ in action

Solution for personal protective equipment

- **Launch time**: August 2021
- **Partner**: Dutch PPE Solutions
- **Application**: Face masks
- Link to the full story

“In the Netherlands, we produce high-quality medical face masks and meltblown filter material with priority to serve healthcare workers and the local industry. With Borealis as a partner, we significantly lower our carbon footprint at the same time”.

MARK BAKERMANS, MANAGING DIRECTOR, DUTCH PPE SOLUTIONS

Thank you!

Anja Gottschalk

Application Development Engineer

Healthcare

Anja.gottschalk@borealisgroup.com