

Eco-Efficient Design

Strategies for Design for Recycling and Intermaterials Replacement

Anja Gottschalk

Healthcare Application Development Engineer

Amel Murgic

Healthcare Application Development Engineer

Borealis GmbH

Introducing Borealis

Introducing Borealis

Key facts and figures

120

Countries. Head Office
in Vienna, Austria

6,200

employees
worldwide



Production and distribution
of advanced and circular
polyolefins solutions and base
chemicals

Ownership structure:

75%

OMV, Austria



Our JV's: Bayport Polymers (Baystar™)
– brings Borstar® technology to American
polyethylene markets



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

25%

ADNOC, United
Arab Emirates

#2

Among polyolefin
producers in Europe

EUR 566million

net profit

121

Priority patents filed
in 2024

5

Polyolefin recycling
operations in Europe

Our commitments



Circular products and solutions

Increase in share of circular products and solutions from today's 150 kt to 1.8 million metric tons by 2030



Emission reduction

Moving from a linear towards a circular economy will also significantly reduce Scope 3** emissions

*** Scope 3 are indirect GHG emissions that are a consequence of company activities but occur from sources outside or not controlled by the company.*

How?

It starts with A / B / C ...

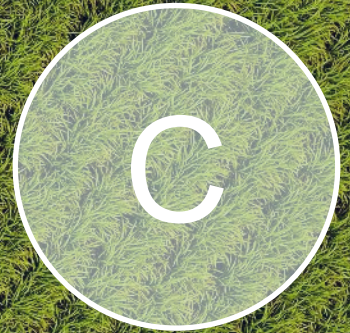
Carbon circularity
will end reliance on
fossil-based
carbon.



Atmosphere
...direct carbon
capture

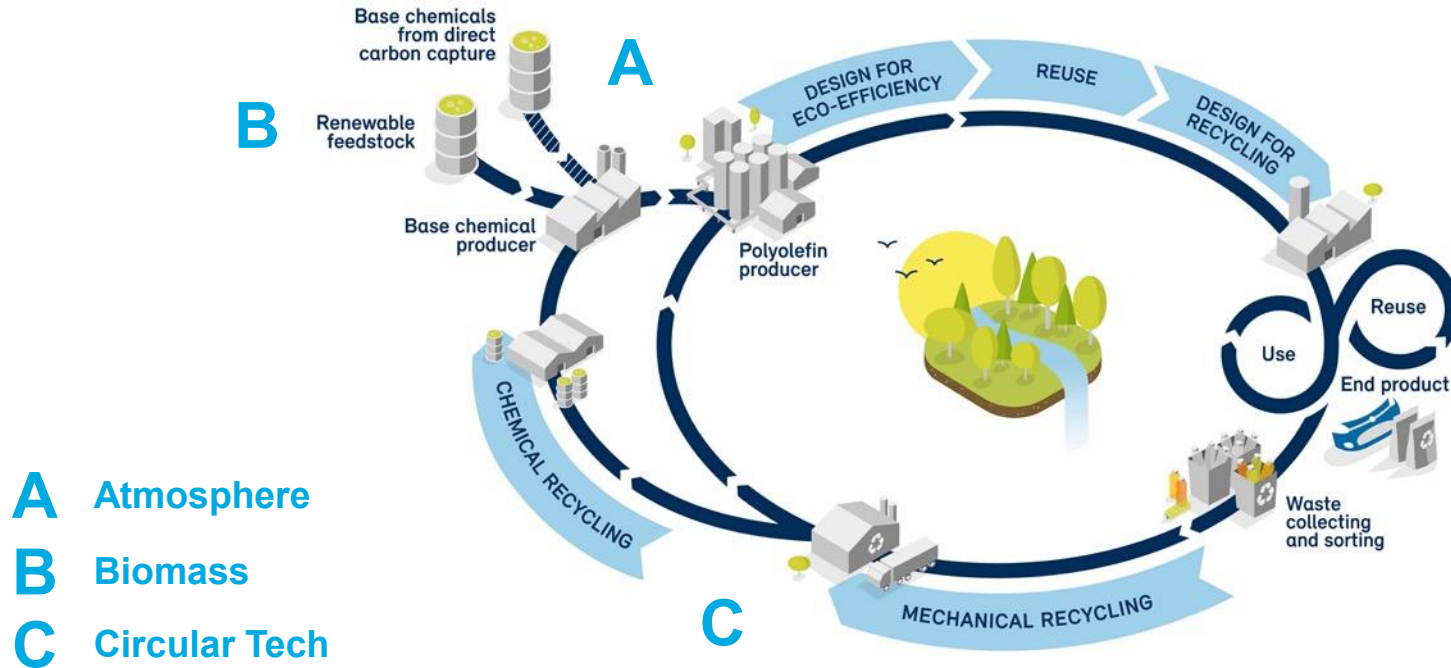


Biomass
...using carbon
from plant-based
feedstocks



Circular Tech
...recycling fossil-
based carbon in
mixed waste streams

Introducing the circular cascade



Circular economy solutions

**How do we integrate
Sustainability in our
Bormed™ offering?**

Borealis is fully committed to closing the loop

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

Eco-efficient design



Eco-efficient design

- Design for recycling so that healthcare applications can be collected, sorted and recycled (e.g. “mono” material)
- Avoiding over-engineering by selecting low carbon footprint materials if possible

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

Borealis is fully committed to closing the loop

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

Eco-efficient design



Eco-efficient design

- Design for recycling so that healthcare applications can be collected, sorted and recycled (e.g. “mono” material)
- Avoiding over-engineering by selecting low carbon footprint materials if possible

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

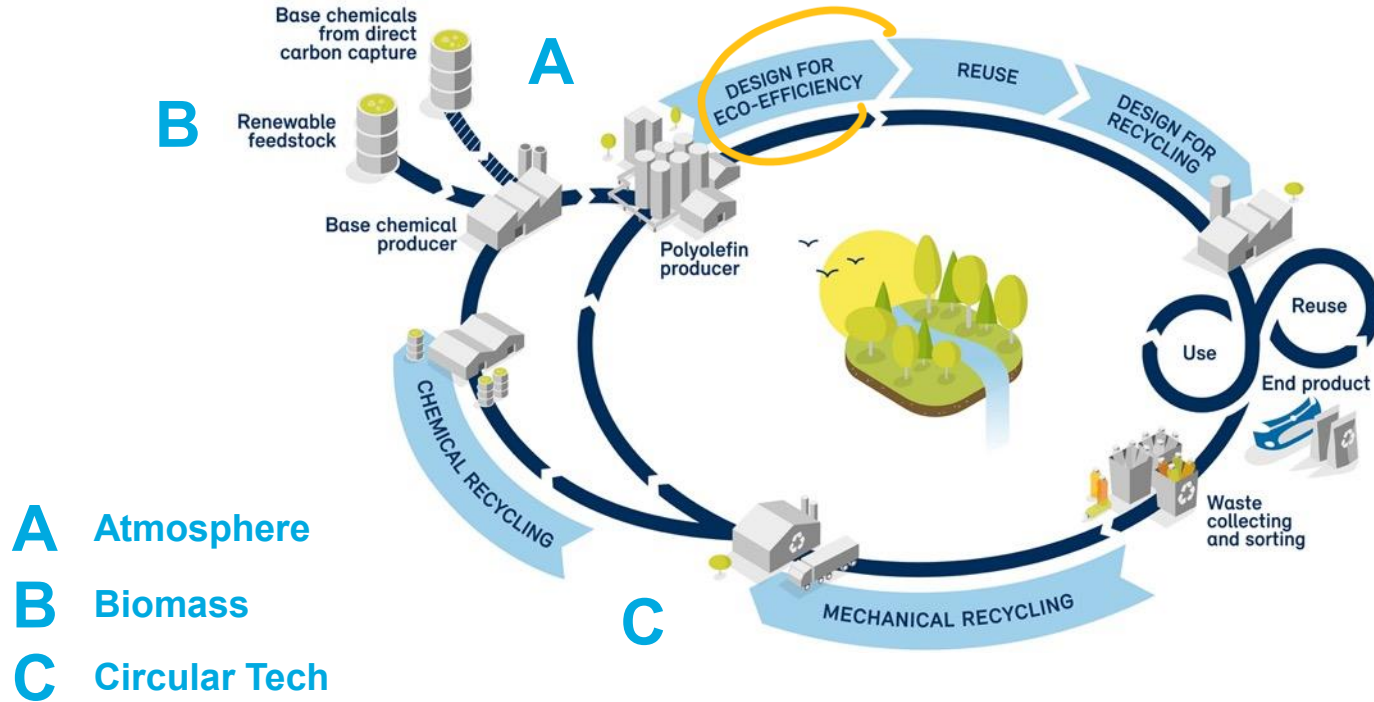
Commercially available solutions for Healthcare

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

Circular economy solutions

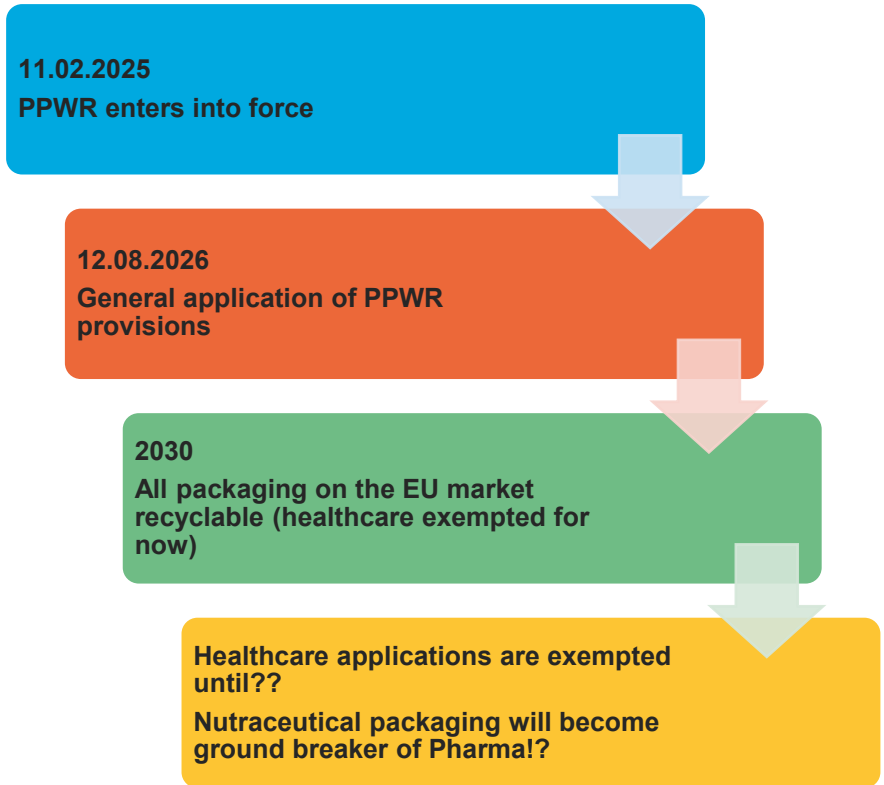
What is eco-efficient design

Introducing the circular cascade



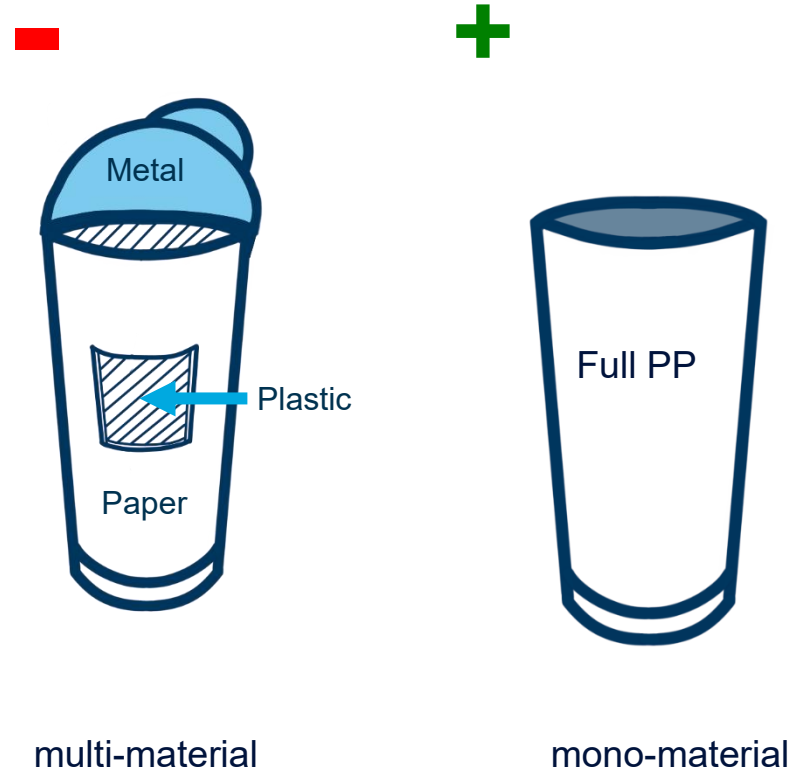
Legislative Context and Changes

- Why is eco-efficient design important for healthcare application?
- The Packaging and Packaging Waste Regulation (PPWR) to replace the corresponding directive from 1994
- Its target to reduce packaging and packaging waste and introduces “**design for recycling**” as key principle
- Since usage of PCR becomes mandatory, registered healthcare applications are exempted
- But: Food contact applications will be within scope and hence, Healthcare applications likely to follow



1. Use PE or PP whenever possible to form a flexible or rigid packaging body

Mono-materials are more easily recyclable than multi-material packaging. Generally speaking, the most efficient and widespread collection, sorting and recycling systems are currently in place for **PE, PP and PET**. While collection and sorting systems for other plastics do exist in certain regions, they are not yet available on an industrial scale.

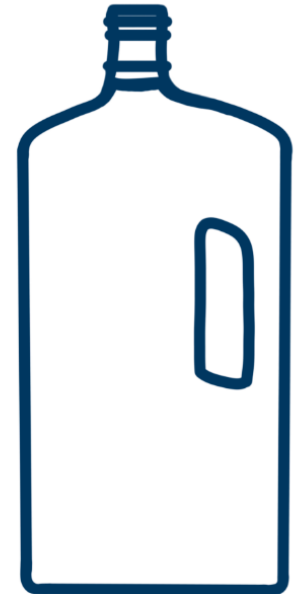


2. Use transparent, clear or white, for the main body of the pack

With existing technologies, it is difficult, costly and sometimes impossible for recyclers to **remove pigments from the pack body**. White pigment body of packaging ONLY if barrier to light is required.



pigmented bottle



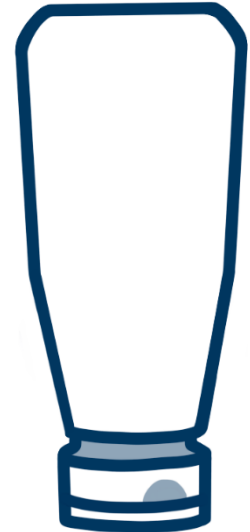
transparent bottle

3. Design the package in such a way that it can be completely emptied after use

If the content of the pack cannot be completely emptied, the **residue complicates the recycling process**. It is more expensive and produces an inferior recyclate (recycled plastic) because the odour, colour or mechanical properties contaminate the final result, and the environmental (LCA) impact of the product is inferior.



hard to empty



easy to empty

4. Use compatible and separable combinations of polymer types, barrier layers, dyes and adhesives

Minimising incompatibilities produces a recyclate with better properties and therefore more suitable for a second life in consumer goods packaging. We recognise that in certain cases there are markets where incompatible resins are necessary to match an application's requirements. For these types of packaging it is necessary to design the packaging so that it can easily be **separated from the PE and PP recycling streams during the washing process** (owing to the difference in densities).



- PVC (main body)
- PVDC
- PET-layers
- PA
- Paper
- PET non-bottle main-body
- PS (main body)
- EPS (main body)
- Silicone



- EVOH
- AlOx
- SiOx
- Metallisation
- Ties
- PE
- PP
- PET (bev.-bottles)

5. Use aluminium foil as a barrier layer only when it can be easily separated from the pack for aluminium recycling

Aluminium foil as an inseparable barrier layer is problematic in the recycling process. If required every effort should be made to **ensure that aluminium foil can be separated from the main pack body** (or fragments thereof containing aluminium particles) for aluminium recycling by means of eddy-current separation.

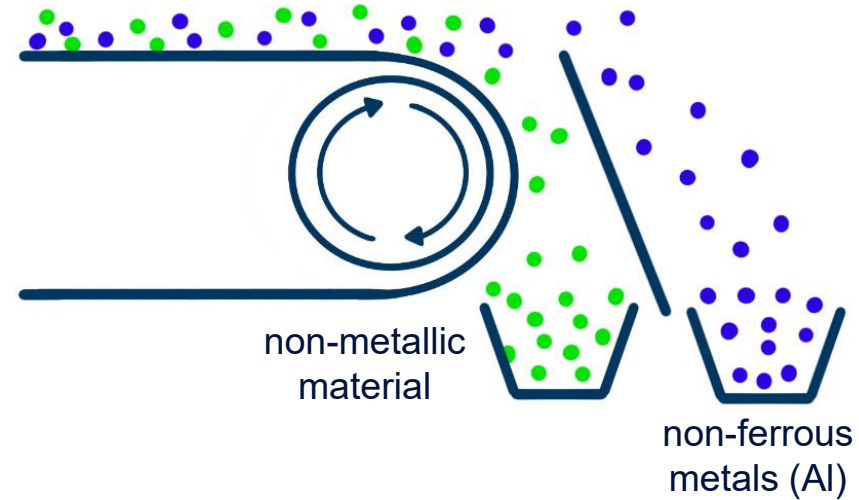


Illustration of an eddy-current separator

6. Follow specific density guidelines when selecting pack components, including labels, sleeves and metallisation

In the recycling process **polyolefin are sorted by density** in a water-based float sink system. This cleanly separates waste streams according to polymer types, such as PE, PP or PET. However, if barrier layers, foaming agents or fillers are used, they change the density of the polymers and this may lead to incorrect sorting. As the type of labels used also affects density, labels and sleeves should ideally be removable and separable by density.

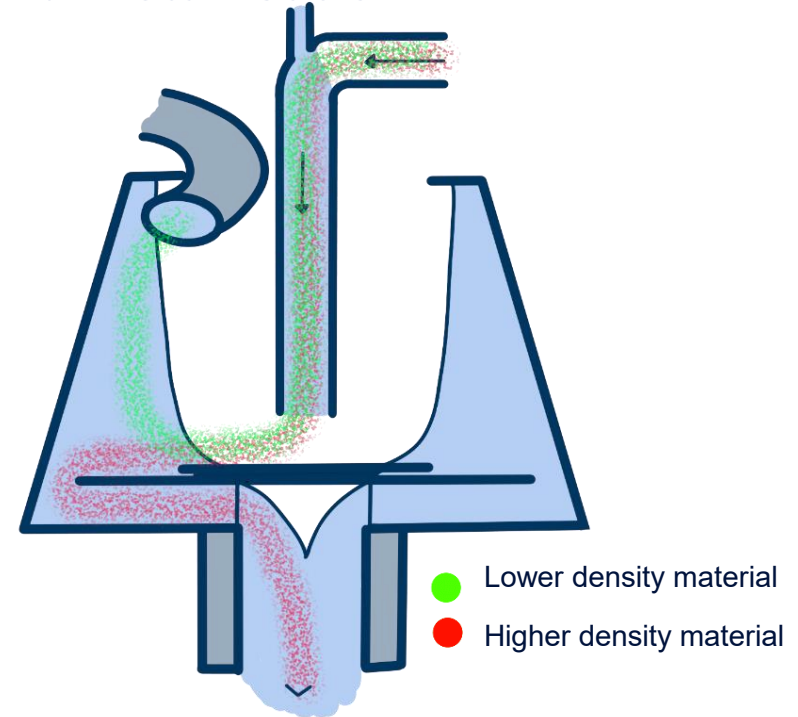
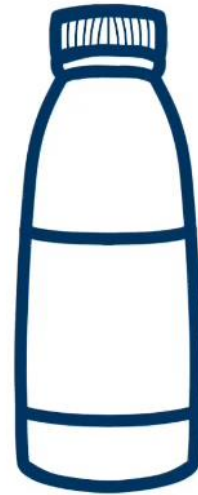


Illustration of a water-based density separator

7. Design labels, sleeves and other on-pack printing in such a way that they can be easily separated from the main pack body. For both PE and PP packs, use the same polymer and same colour for the entire pack – body, caps, closures and labels

Labels, sleeves and other **on-pack components** complicate the recycling process and contaminate the recycled product. Ideally they should be **completely removable**. On-pack pigments and colours applied through direct, reverse or trap printing can only be removed in the recycling process through a short friction washing cycle using natural water at temperatures of up to 50° C.



easy to remove sleeve

7. Design labels, sleeves and other on-pack printing ...

[continuation...]

If friction washing at 50°C is not sufficient to remove the label from pack body such as for in-mould labels, **use washable inks**. It is preferable to **print only the most essential information** to fulfil legal requirements (sell-by date, batch number, etc.) directly on the main body pack. Consistency in components helps the optical scanner sort the packs correctly for recycling.



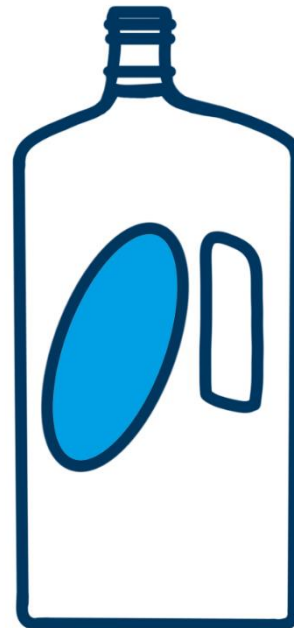
full body printed label

8. Use as little surface space as possible for printing or labelling on the pack

As a rule, the **less space** taken up by a **label or printing inks**, the more likely the pack is to be recognised during sorting and results in higher quality recyclates.



full body label



small label

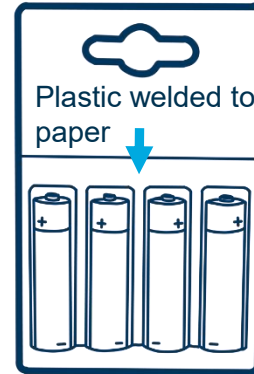
9. Use light-coloured, non-gassing inks for essential on-pack information

Inks that cannot be removed and thermally neutralised during recycling disrupt the process. It is therefore very important to **use light-colored, non-gassing inks** that are temperature resistant up to 240° C

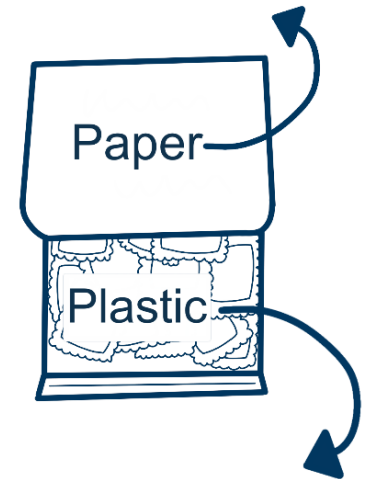


10. Ensure that when paper is designed in combination with plastics on a single pack, it must be separable and separated from the main plastic body by the end user in order to access the contents

Paper fibres cannot be effectively removed in the recycling process as it clings to polymer flakes and degrades under heat, setting off gasses, and otherwise causing discolouration and odours. It is essential that the end user can **separate the paper from the main plastic body of the pack**.



Not necessarily separated for access to product



Separated during use

Bormed™ Portfolio as enabler for eco-efficient design

What is your key performance criteria?

Bormed™ PP portfolio has potential to replace engineering polymers with its optimised performance characteristics enabling sustainable processing and efficient designs

Key Performance Criteria	PP	PC /ABS	ABS	PC	PBT	POM	PA6
Stiffness @ room temp.	1100-1900 MPa	2000-2600 MPa	1300-2700 MPa	2100-2400 MPa	2000-2300 MPa	1600-3200MPa	1000-1400MPa
Yield Strength @ room temp.	25-40MPa	40-60MPa	45-65MPa	55-65MPa	50-60MPa	60-75MPa	45-80MPa
Toughness	Good	Good	Fair	Good	Fair	Fair	Very Good
Transparency	Good	Poor	Poor	Very Good	Poor	Poor	Poor
EtO Sterilisation	Good	Good	Good	Good	Good	Good	Good
Steam Sterilisation @ 121C	Good	Poor	Poor	Fair	Fair	Good	Fair
Radiation Sterilisation	Fair	Good	Good	Good	Good	Poor	Fair
Chemical Resistance	Very Good	Fair	Good	Poor	Fair	Fair	Fair
Processability	Good	Fair	Good	Fair	Fair	Fair	Good
Density	0,90-0,91gr/cm3	1,08-1,17gr/cm3	1,03-1,07gr/cm3	1,20-1,24gr/cm3	1,30-1,32gr/cm3	1,41-1,43grcm3	1,12-1,15gr/cm3

- Grades with [high modulus up to 1900 MPa](#) for thin wall and insert sections of medical devices where high stiffness is key for robust design
- Grades with excellent balance between [high toughness & high flow](#) at low temperature
- [Sterilisation compatible](#) grades for EtO , Steam at 121°C and gamma radiation
- Very good [chemical resistance](#)

Circular economy solutions

Examples of eco-efficient design in Healthcare

PP blister pack, a >25 year reliable and proven solution

Award winning in the past, ready to address present challenges

What are today's renewed challenges?

- Increase package performance, e.g. shelf life
- Environmental sustainability meeting pharma company pledges
- Increased regulatory compliance needs
- Match packaging performance of existing blister forming lines

Bisherige Prämierungen / Awards of the packaging-system

- Österreichischer Staatspreis 1993 für vorbildliche Verpackung
- Austrian state award 1993 for exemplary packaging
- Gewinner im 18. deutschen Verpackungswettbewerb
- Award of the 18th german packaging competition



Source: Borealis (PCD) PP mono blister brochure, September 1995

Plastic packaging recycling begins with design

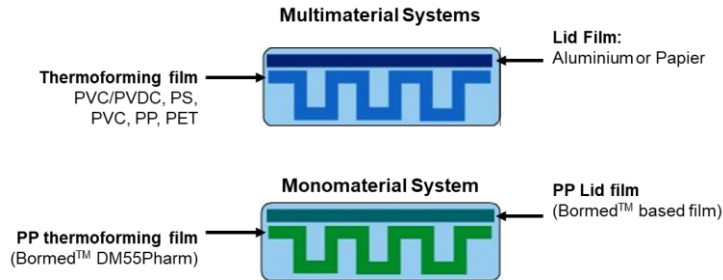
“Mono-material” from one polymer family can enable increase of future mechanical recycling rates

- Design for recycling (DfR) is becoming an aspect to consider for **eco-efficient design** of healthcare applications which – on the basis of a life cycle approach – needs to carefully and intelligently balance the production, usage, and after usage phases of a product
- DfR means designing a product so it can be **collected, sorted, and recycled**, by making appropriate material choices and intelligent design decisions

Example: Borealis “mono blister”



- Substitution of PVC/Al blister materials with 100% PP solution
- Key benefit: 70% improvement of carbon footprint vs currently used systems*



Bormed™ material of choice for laryngoscope

Advancing Sustainability of Medical Devices

In a significant move towards enhancing sustainability in healthcare, Sanitas Healthcare, recently launched the Protect Laryngoscope (VL). Borealis' portfolio of the Borneables™ materials played a crucial role in the development of the Protect VL. This innovative medical device exemplifies both companies' commitment to providing solutions in the healthcare industry that address clinical excellence and environmental responsibility.

[Link](#) to the full story.

The Protect VL project was born out of a vision to reduce the environmental footprint of medical devices. Designed to be substantially reusable, the Protect VL features a single-use element made from a single material with excellent recycling potential, setting it apart in the realm of sustainable medical technology.

MARK WILKINSON, TECHNICAL DIRECTOR, SANITAS HEALTHCARE



© Borealis

Bormed™ material of choice for laryngoscope

Advancing Sustainability of Medical Devices

	PC ¹	ABS ¹	PP ¹	Bornewables™ PP ²
Part volume	60 cm ³	60 cm ³	60 cm ³	60 cm ³
Part weight	72 g	64.2 g	54.6 g	54.6 g
Reduction in weight	0 %	- 11 %	- 24 %	- 24 %
Annual raw material	14.4 tonnes	12.8 tonnes	10.9 tonnes	10.9 tonnes
GWP (CO ₂ equiv.)	48,9 tonnes	34,4 tonnes	17,8 tonnes	0,12 tonnes
Reduction Change in GWP	0 %	30 % reduction	73 % reduction	99 % reduction

- Source: EcoProfile from Plastics Europe
- Source: Borealis LCA

The Protectv VL project was born out of a vision to reduce the environmental footprint of medical devices. Designed to be substantially reusable, the Protect VL features a single-use element made from a single material with excellent recycling potential, setting it apart in the realm of sustainable medical technology.

MARK WILKINSON, TECHNICAL DIRECTOR, SANITAS HEALTHCARE



© Borealis

Bormed™ material of choice for injector pens

Advancing Sustainability of injector pens by introducing Bormed materials in different pen injector components

- Polyolefins offer significant advantages compared to engineering polymers in terms of price and sustainability
- A comparison was performed on autoinjector (outer housing)
- Company producing 4 million autoinjectors per year

Criteria	PC/ABS ¹	PP	Renewable PP
Housing weight	19,8 g	15,7 g	15,7 g
Raw material volume per year	79 t	63 t	63 t
Plastic use reduction	Reference	-20%	-20%
Cost reduction per kg	Reference	-40%	0%
Cost reduction in total	Reference	-54%	-20%
GHG Emissions	251 t CO ₂ e ²	101 t CO ₂ e ³	-14,5 t CO ₂ e ³
GHG Emission reduction	Reference	-60%	-106%

1.PC/ABS blend 70:30

2.Source : EcoProfile from Plastics Europe / no compounding step considered

3.Source : Borealis LCA



Thank you!

Anja Gottschalk



Application Development Engineer

Healthcare

Anja.gottschalk@borealisgroup.com

Amel Murgic



Application Development Engineer

Healthcare

Amel.murgic@borealisgroup.com