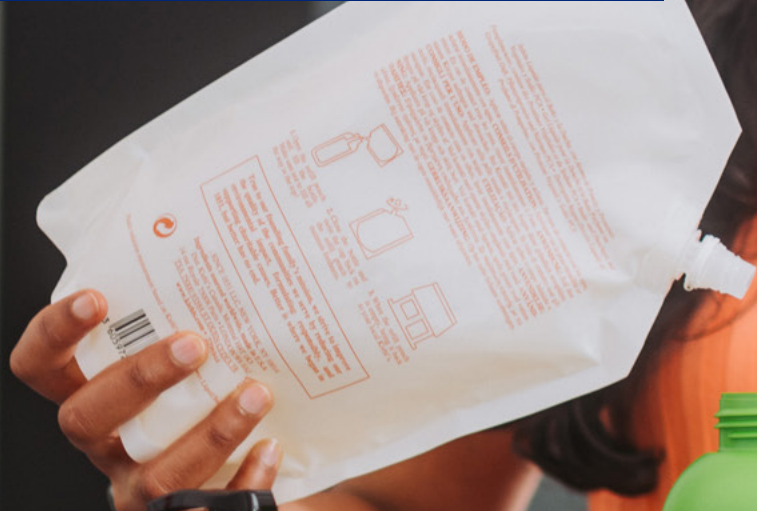


CASE STUDY

Lightweight bottle made with 100% PCR exhibits excellent performance characteristics

Borealis and partners are putting the principles of reuse, reduce, and recycling into practice for greater packaging sustainability



In partnership with



Smart innovation enables our customers to meet their sustainability targets



Accelerating Action
on Circularity

In the EverMinds™ spirit of value chain collaboration to accelerate plastics circularity, Borealis and its partners sought a way to make one of the most universal packaging applications – the one-liter plastic bottle – more sustainable and affordable. Is there a way to make a lighter bottle that passes performance tests (such as drop and top load tests), offers the same appealing look and feel of a bottle made of virgin polyolefins, yet is affordable to produce?

First, Borealis partner **W. MÜLLER**, a technology leader in blow molding, showed that its extrusion unit and head can be used to upcycle existing machinery to accommodate the use of post-consumer recycle (PCR) in manufacturing. Reusing equipment in this way fulfills high production standards in PCR foaming and processing. Second, **Trexel**, another trusted partner and leading expert in foaming injection and blow-molded parts, showed how to reduce bottle weight by maximizing the foamability cell structure. Its license fee-free MuCell® technology for the physical foaming process is used to inject gas into a middle layer, resulting in a lighter-weight bottle. Third, **Borealis**, with one of the deepest and most diverse offerings of recycled and renewable-based material solutions in the industry, supplied a grade from its Borcycle™ M portfolio of advanced mechanical recyclates for nonfood-contact applications. The Borcycle M grade selected for this bottle application is odorless, does not require the use of white pigment, and boasts excellent foamability. The use of this grade produces a bottle that can be reused or 100% recycled at the end of its (first) life.



This 100%-PCR bottle passes performance tests with flying colors

Quality control tests were carried out on eight different types of solid and foamed bottles, each made of 100% PCR materials. Overall, very satisfactory results were obtained by using a combination of good cell structure (enabled by the Trexel pump and its stabilized flow, which maintains a consistent thickness); good layer distribution (ensured by W. MÜLLER's head design); and a recycled polypropylene (rPP) which is of high quality and foamable (the Borcycle M grade provided by Borealis).

Results of drop tests varied according to the extent to which density reduction and cell morphology affected cell reduction. Synergy effects between the gas and the nucleant produced a cell structure that minimized the effects of a reduction in drop impact. Test results for solid versus foamed solutions in bottles made of 100% PCR are depicted in Table 1 below.

	Solid	Foam
Thickness, mm	0.80	0.86
Density, kg/m3	955	840
Weight, g	59	52
Layer ratio, % (out/core/in)	20/65/15	20/65/15
Topload, N	518	518
Drop height, m	>2.5	>1.8

Table: 100% PCR trials for solid vs foamed solutions © Trexel 2024

The stiffness-to-weight ratio of bottles made using 100% PCR content can be improved using foam. This compelling advantage can be leveraged across a wide range of packaging applications. A comparison of top load test results is illustrated below.

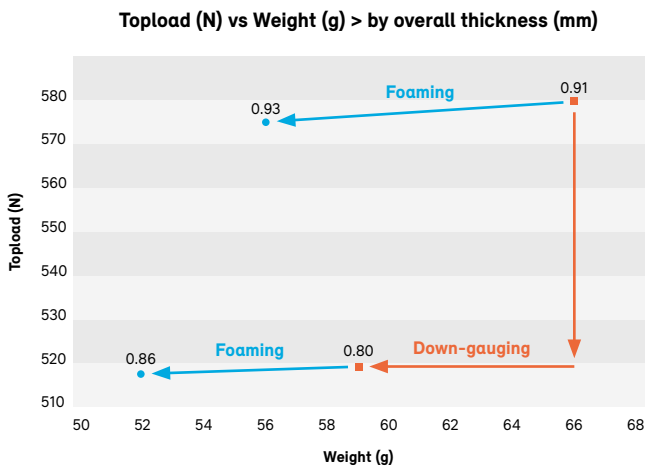


Illustration: Foaming vs. downgauging © Trexel 2024





The benefits of this solution at a glance:

- Incorporation of up to 100% PCR yields high quality application
- Use of foaming and Borcycle M grade results in a bottle weight reduction of up to 17% versus solid 100% PCR bottle
- Foamed 100% PCR bottle produces same top load test results as solid 100% PCR bottle
- Foamed 100% PCR bottle fulfills drop test requirements
- Borcycle M grade has no odor
- Good foamability when using Borcycle M grade
- Foaming enables more opacity without the use of white pigment
- Offset of green tinge
- Cost efficient thanks to use and/or upgrade of existing equipment, no licensing fee, and lower energy consumption in production (same required cycle time)
- Recyclable solution with option to reuse/ refill

Lighter weight, robust performance, aesthetic appeal, affordability

The combined know-how of the three partners produced a cost-effective solution that makes it easier for bottle manufacturers – and by extension, brand owners – to switch materials and upgrade machines to achieve their sustainability targets. The functionality of the 100%-PCR bottle is nearly the same as one made with virgin materials. What is more, foaming enables a potential weight reduction of up to 17%.

“To achieve the same excellent results obtained in this project, good layer distribution is crucial, and at least two layers are required. As leaders in multilayer products, we offer a superior head channel design that can be used for new machines, or to retrofit existing equipment from leading manufacturers. By enabling the reuse of expensive machinery for more sustainable production, we can help more and more producers switch from virgin to rPOs in an affordable way.”

Christian Müller

Managing Director, Blow Molding Technology, W. MÜLLER GmbH

“Foaming can preserve stiffness while reducing weight, which is something that can’t be achieved through solid downgauging alone. We offer better foamability thanks to our MuCell® technology and equipment. This collaborative project shows that bottle weight can be significantly reduced while at the same time maintaining its performance characteristics. If we have already achieved a 17% reduction, then even more ambitious goals like 30% are clearly within reach.”

Levi Kishbaugh
President/CEO, Trexel Inc

“Borealis offers one of the broadest ranges of recycled and renewable-based polyolefins on the market so as to support our customers and partners in meeting their own sustainability goals. Our transformative Borcycle M technology generates material solutions that provide all the sustainability-related advantages of recyclates, but none of the disadvantages, such as odor. This project not only points to new market opportunities for rPOs. It is also an inspiring example of how we can reinvent essentials for more sustainable living.”

Florin Sabau
Global Commercial Director, Rigid Packaging, Borealis

Borealis and Borouge packaging solutions are making everyday life easier

date of issue: April 2024

Borealis is one of the world’s leading providers of advanced and sustainable polyolefin solutions. In Europe, Borealis is also an innovative leader in polyolefins recycling and a major producer of base chemicals. We leverage our polymer expertise and decades of experience to offer value-adding, innovative and circular material solutions for key industries such as consumer products, energy, healthcare, infrastructure and mobility.

With operations in over 120 countries and head offices in Vienna, Austria, Borealis employs around 6,000 people. In 2022, we generated a net profit of EUR 2.1 billion. OMV, the Austria-based international oil and gas company, owns 75% of our shares. The Abu Dhabi National Oil Company (ADNOC), based in the United Arab Emirates (UAE), owns the remaining 25%.

In re-inventing essentials for sustainable living, we build on our commitment to safety, our people, innovation and technology, and performance excellence. We are accelerating the transformation to a circular economy of polyolefins and expanding our geographical footprint to better serve our customers around the globe. Our operations are augmented by two important joint ventures: Borouge (with ADNOC, headquartered in the UAE); and Baystar™ (with TotalEnergies, based in the US).

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