Automotive Interior Solutions

Optimised performance and surface aesthetics

BOREALIS

Borouge

Contents

Borealis Worldwide

○ – Borouge Locations

Head Offices
Singapore, UAE

Innovation/Application Centres
China, UAE

Production Plants
China, UAE

Sales Offices/Representative Offices
China, India, Indonesia, Japan, Singapore, Thailand, UAE, Vietnam

Logistics Hubs
China, Malaysia, Singapore, UAE

○ – Borealis Locations

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Customer Service Centres
Austria, Belgium, Brazil, Finland, France, Hungary, Turkey, United States

Production Plants
Austria, Belgium, Brazil, Finland, France, Germany, Italy, Sweden, The Netherlands, United States

Innovation Centres
Austria, Finland, Sweden

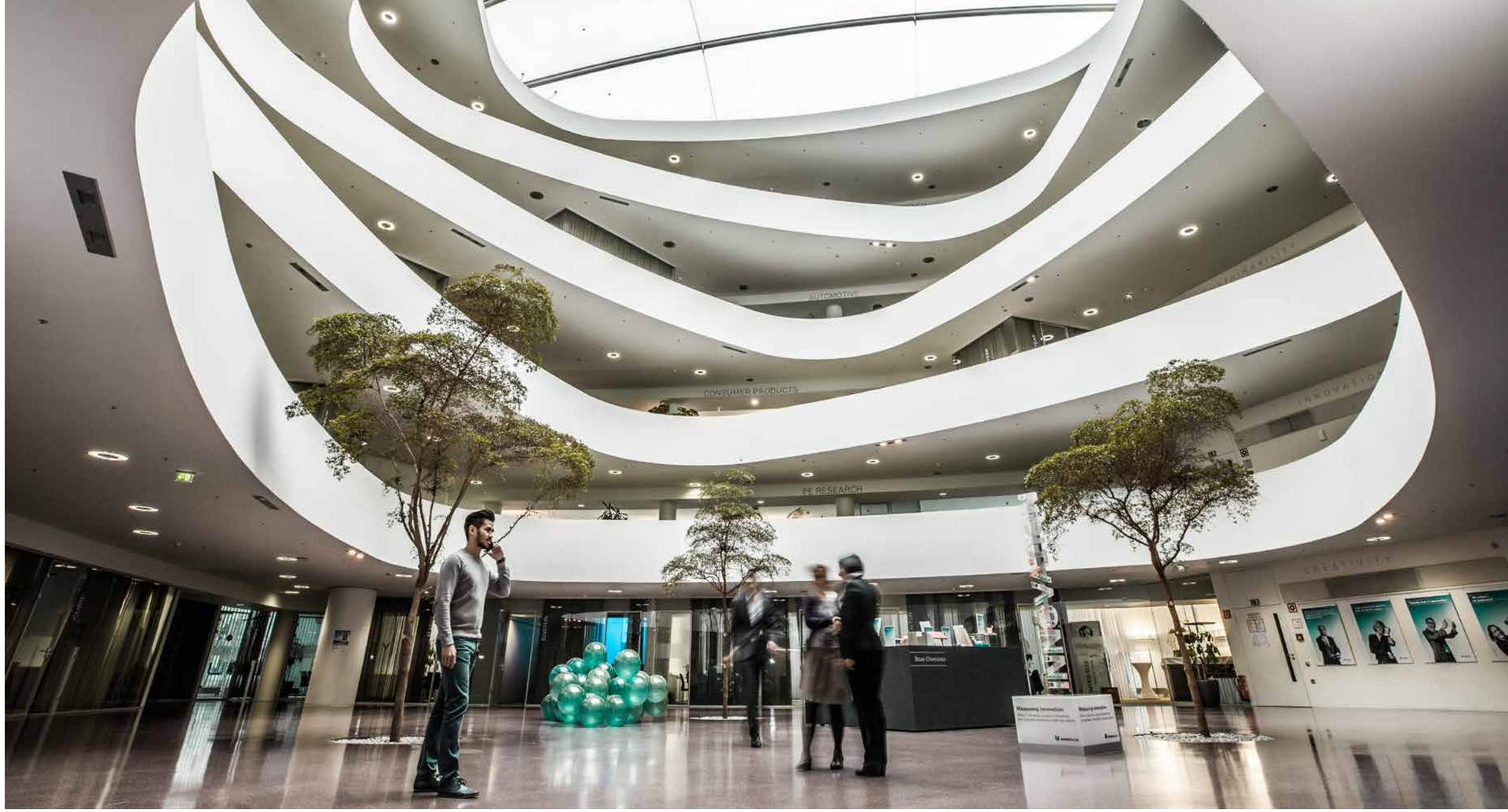
Sales Offices/Representative Office
Argentina, Chile, China, Colombia, Czech Republic, Denmark, France, Hong Kong, Mexico, Morocco, Poland, Russia, South Africa, Spain, Turkey, UAE, UK

Borealis L.A.T Locations
Austria, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Romania, Serbia, Slovakia

Borealis Rosier Locations
Belgium, The Netherlands

The purpose of this visualisation is of representational nature only. Though it was prepared with the greatest possible attention to detail, simplified illustrations may have been applied.

Our Key Messages



Aesthetics

Providing freedom in design and delivering innovative surface aesthetic solutions.
Borealis interior material solutions are easy to process into even complex geometries and surface textures. The materials are tailored to ensure excellent part appearance in a wide set of parameters, creating long lasting aesthetic surface with high scratch resistance!

Global Expansion

Expanding global supply capabilities and strengthening global support on a local basis.
Borealis and Borouge have a global footprint, providing tailored support to automotive tiers and OEM partners around the world.

Global production. We have 16 production sites making polyolefins for many different applications. Several of our European, Asian, North and South American plants produce specific thermoplastic polyolefins and polypropylene compounds for the automotive industry.

Lightweight

Reducing vehicle weight with global innovation.
Borealis and Borouge are driving innovations in car materials. Working with vehicle manufacturers and other value chain partners, we are dedicated to realising tangible benefits for the industry, drivers, and the environment.

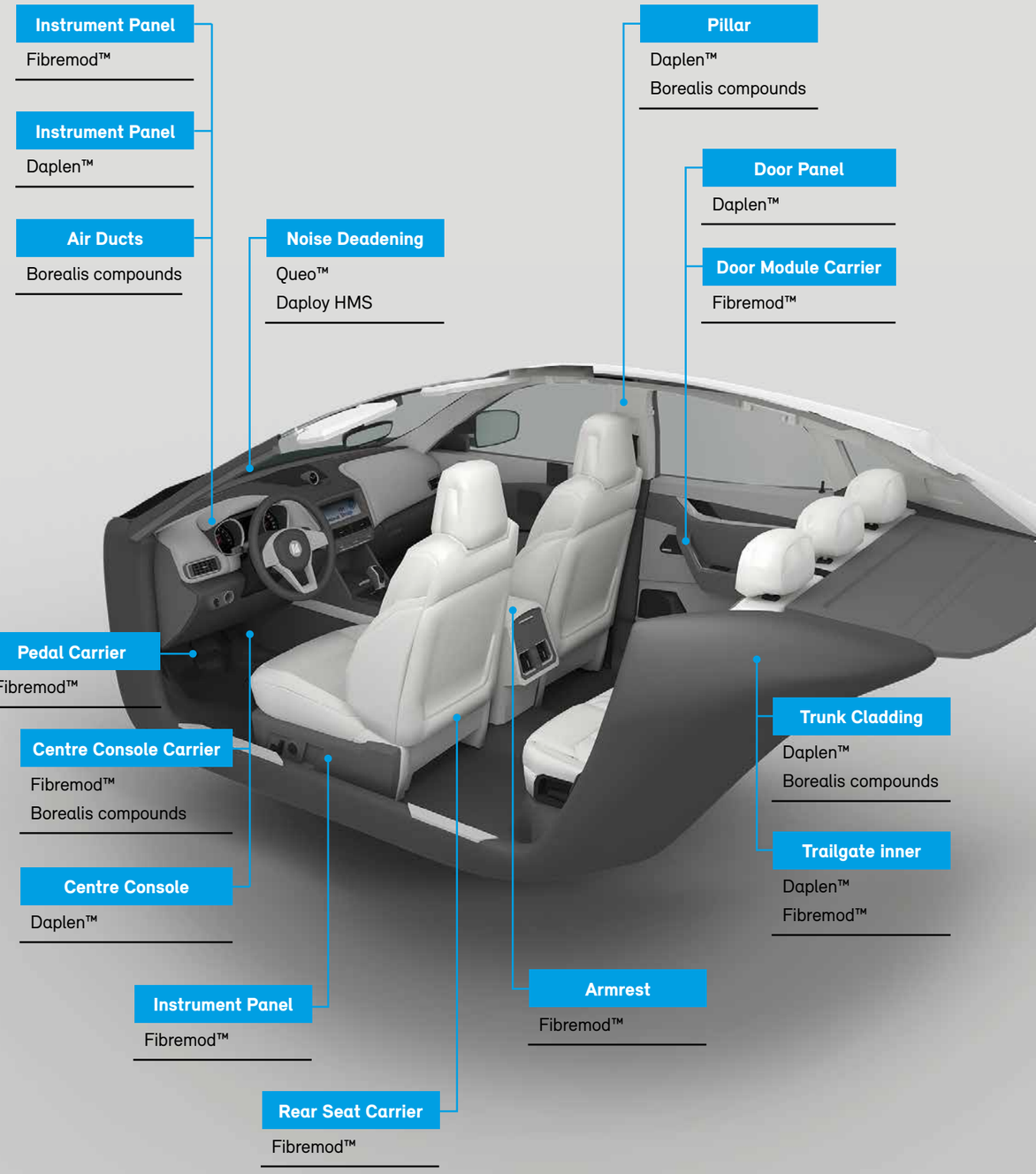
In addition to our cutting-edge innovation, we offer our partners the assurance of unrivalled quality control and a global footprint.

Dedicated to automotive solutions

For Borealis, automotive is a business segment where we apply our specialist knowledge and decades of experience. We are focused on the development of ‘creative innovation’ polypropylene (PP) and thermoplastic polyolefin (TPO) solutions for automotive applications.

Whether you are producing dashboards, door panels, centre consoles, trims or structural components, Borealis is the right partner. Our comprehensive range of PP and TPO polymers and compounds have properties that are balanced and tailored to precisely match the needs of the the automotive industry. As such they add value through helping manufacturers to lower system costs, while providing reliable performance to the highest global industry standards, as well as enabling faster development-to-production cycles. And, no less importantly, they reduce both material and energy inputs for enhanced sustainability. Our latest generation of Daplen™ and Fibremod™ grades combine lowest densities with excellent surface aesthetics and high purity. Key features that are helping to reduce the material mix in interior applications and increasing the recycling readiness of cars.

Daplen™ EF098HP at the new Daimler A-Class door cladding.



Staying ahead of trends

Our close working partnerships with OEMs and Tier 1 suppliers over many years have given us a unique understanding of automotive value chain needs. Our ongoing dialogue with industry partners is of special importance, as it enables Borealis to identify and act on evolving market trends. Our Visioneering™ Philosophy and intense collaboration with leading universities and institutes keeps us in the forefront of polymer research helping us to continuously enhance our technology toolbox.

This allows us to focus the resources and scientific skill-sets of our Innovation Centres on ensuring optimal, differentiated and integrated solutions that meet tomorrow’s needs, before they become tomorrow’s challenges.

Daplen™ Interior Solutions
Satisfying aesthetic, purity and performance demands

Visual appearance is the first and dominant influence on the buyer's perception of vehicle quality. Our PP and TPO resins and compounds are developed to make a positive contribution to that perception through, for example, the generation of appeal through low gloss, scratch resistant interior trims and cladding that emphasise style, as well as providing for the design freedom that complements aesthetic objectives.

The sense of touch has a special relationship to the way we connect with our surroundings and through it our appreciation of comfort. The haptic characteristics of our PP and TPO materials for passenger contact applications, such as smoothness, grained effect, soft-touch or stiffness, are given special consideration in our material developments. No less attention is paid to the material's low emission and odour, non-fogging and sound dampening characteristics, which complete our perception of quality and the comfort of our driving experience.

Advanced material characterisation techniques and state of the art modelling and simulation tools enable our CAED experts to optimise part designs, evaluate tooling concepts, define processing conditions and simulate part behaviour under various loads early in the project phase. An essential tool to reduce development time for new parts and ensure efficient and stable production processes at our customers.

Delivering premium surfaces

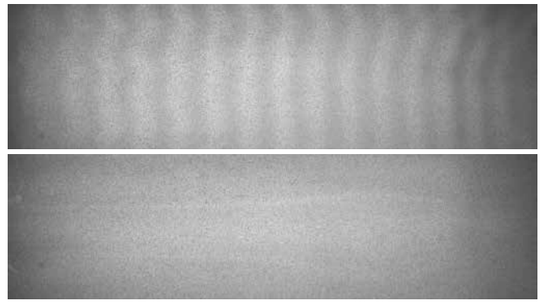
Vehicle interior surfaces have a major influence on buyers' perception of quality. Where a quality feel and finish was once considered the preserve of expensive, high-end brands, today it is a common goal across a car manufacturer's model range.
Interior aesthetics are therefore an important opportunity for car makers to differentiate their offering in an increasingly competitive market.

Borealis PP and TPO materials meet OEM objectives with optimised solutions that deliver surfaces exhibiting:

- Haptics
- Non-stickiness
- Low gloss and mar resistance
- High scratch resistance
- Absence of flow marks (tiger stripe-free)

Flawless surfaces

Borealis has launched a number of new grades based on a proprietary PP matrix exhibiting flow mark free performance. This Borealis innovation, is contributing to the avoidance of flow marks on applications across a very broad processing window.
These innovative solutions allow our customers to increase production output without any compromise in surface quality.

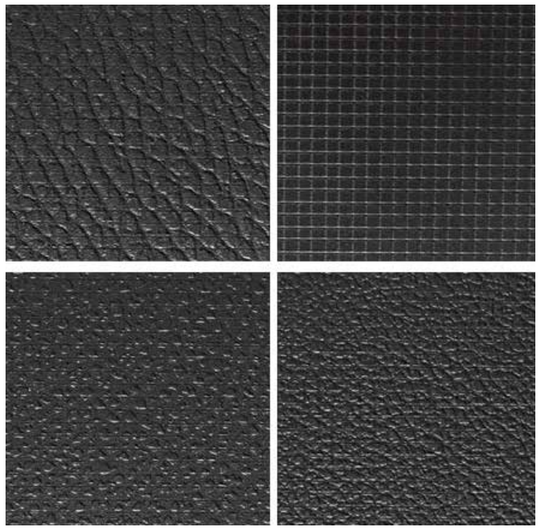


Borealis Tiger Stripe Tool at the Innovation Headquarters Linz

Durable surfaces with perfect colour match

Colouring

Colour impression and colour harmony across different interior parts is another key aspect for the aesthetic quality of a car's interior. Borealis has several decades of experience in the development of colours and the production of in-mass coloured PP and TPO compounds. We offer ready-to-use materials from very bright to dark colours as well as special effect colours (e.g. metallic). High quality standards and comprehensive quality control measures ensure that our production plants keep colour variations within narrowest tolerances and that every batch is produced in accordance to the respective OEM colour requirement.



Durable appearance and performance

To ensure that interior components, like dashboards, inner door panels and pillar trims maintain a high aesthetic appearance over the long-term, material scratch resistance is especially important to protect against abrasions and marring.

However, interior mouldings predominantly use grained or textured surfaces, determined by the tool used, and these can have a significant impact on scratch resistance properties. Therefore, Borealis materials for interior applications have been developed specifically to deliver improved grain effect in combination with superior resistance to scratching.

Processing for optimal property balance

Borealis and Borouge PP and TPO solutions for interior components are formulated to provide the characteristics necessary for enhanced processing, including:

- A broad processing window
- High flow – enabling ease of filling complex geometries and long, thin wall constructions
- Low shrinkage
- Faster cycle times for increased machine utilisation and productivity

However, Borealis offers processing guidelines that can unlock the fuller potential of Borealis tailor-made solutions. For example the final emissions and odour level can be greatly affected by the processing parameters in the part production. In particular the conversion temperature and applied shear rates respectively can have a major impact on emission, fogging and odour generation. Borealis is providing processing recommendations and offering simulation support for best results.

Tensile creep testing equipment at Borealis Innovation Headquarters Linz

Emissions and odour under control

The Borealis lab is equipped with state-of-the art emission, fogging, odour testing infrastructure, and accredited according the main industry standards. In addition emission testing is part of the extended quality control in our production plants.

These tools enable us to provide high purity PP and TPO compounds to the market. We also support the optimization of production processes at our customers aiming to deliver interior parts that comply with latest OEM requirements.

Underwritten by safety

While the aesthetics of parts made of our PP and TPO solutions are important, their safety performance is paramount. In the event of a collision, the impact resistance and non-splintering behaviour of panels and fascias contribute to driver and passenger safety – adding a further level of comfort.

Borealis interior material solutions are designed to ensure an optimum balance between stiffness and toughness meeting latest customer requirements. Our broad variety of in-house testing facilities enables us to characterise material behaviour under static and dynamic loads a prerequisite to prepare state-of the art material models and predict final part behaviour under load.

Daplen™ Interior Applications

Borealis' comprehensive portfolio of Daplen™ mineral filled TPO compounds is covering a wide range of automotive industry standards. Daplen™ interior solutions are mainly used for visible interior applications like dashboards, door claddings, centre consoles etc. These low density materials are combining excellent aesthetics and purity with well balanced mechanical properties resulting in parts with high perceived quality.

Daplen™ EE001AI

VW Touraeg, Audi A1, Skoda Scala and VW T-Cross door panel made from EE001AI, a very low density mineral filled, impact modified interior material with high purity and surface aesthetics.

Benefits

- Easy processing
- Excellent surface appearance
- Fulfilling latest VOC, FOG and odour specifications
- Excellent scratch resistance with no tackiness

Daplen™ EE058AI

Skoda Scala centre console, glove box and lower dashboard trim made from EE058AI a very versatile low density material solution enabling a part weight complexity reduction compared to the previous vehicle generation.

Benefits

- Excellent scratch resistance with, no tackiness
- Balanced stiffness and toughness level suitable for various applications
- Excellent processability allows production of highly designed interior parts
- Low emissions, fogging & odour

Daplen™ EF098HP

Daimler A-Class and B-Class door claddings, tailgate cladding and interior trims made from EF098HP, a 10% mineral filled premium surface appearance PP compound with high purity.

Benefits

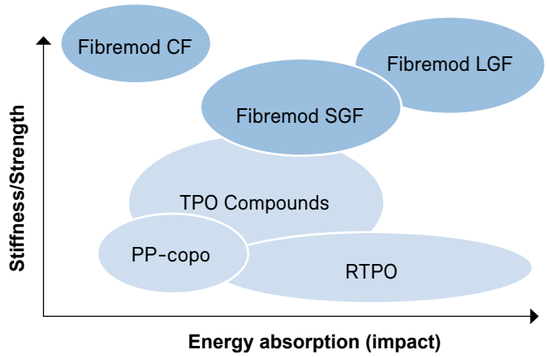
- Fulfilling latest VOC, FOG and odour specifications
- Superior surface aesthetics
- High scratch resistance
- Easy processing

Fibremod™ – Superior properties and benefits

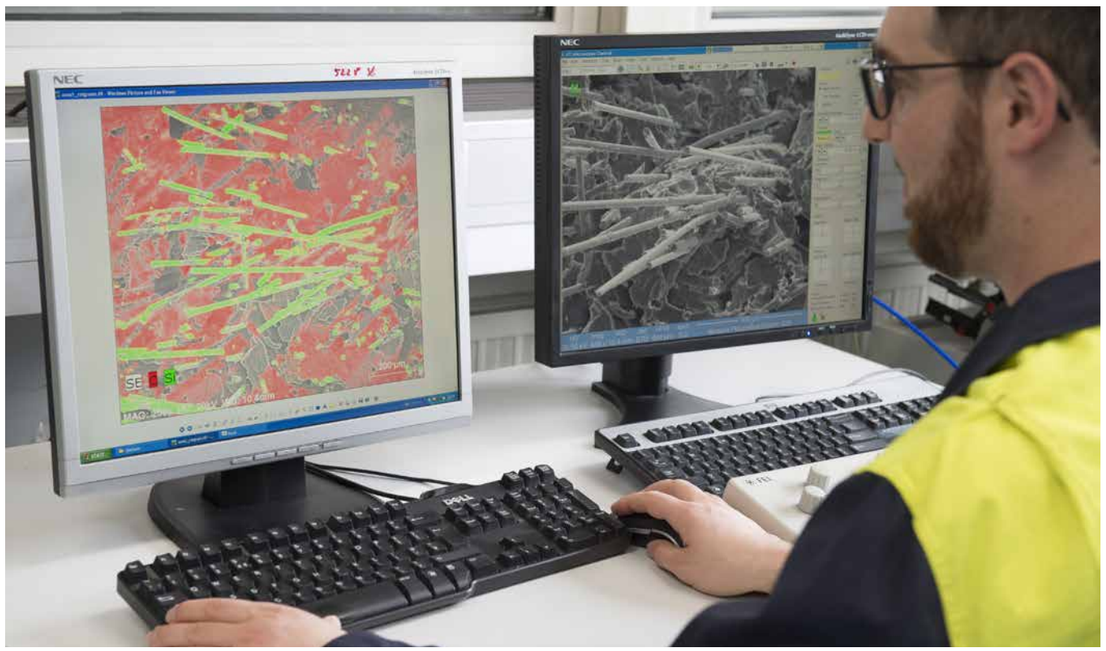
Stiffness and impact performance

Fibremod technology combines Borealis' expertise in product development, its unique production process for glass fibre reinforced materials and tailored customer support. This combination maximizes the fibre length in both pellets and the final part providing the optimal balance between strength and energy absorption.

Comparison of expected stiffness and impact balance of unreinforced PP compounds and PP reinforced with SGF, LGF and CF.



The comparison of stiffness and impact performance of different PP reinforced grade families shows that Borealis' Fibremod portfolio offers significantly higher stiffness for a given level of impact performance, compared with unreinforced PP compounds.

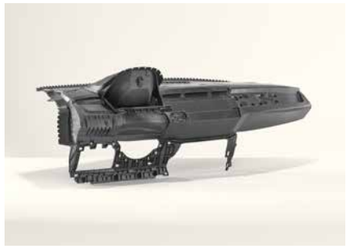


Scanning Electron Microscopy of fibre reinforced PP at Borealis labs

Fibremod™ Interior Solutions
Lightweight structural components

For application such as structural carriers, requiring optimal stiffness/toughness balance our reinforced PP compounds provide the strength and durability to replace metals. In doing so, they enable significant vehicle weight savings and greater fuel economy without any compromises in mechanical properties. Moreover, they give reliable, corrosion-free performance throughout a vehicle's lifespan.

Fibremod™ GB601HP+ EE002AE BMW



BMW 1,2,3,4 & 8-series, X1 and Mini Clubman instrument panel carrier in foamed PP long glass fibre 20% made from Fibremod GB601HP, a 60% long glass fibre reinforced PP compound diluted with EE002AE, a high impact strength elastomer modified PP resin.

Benefits
- Weight reduction
- Lower system costs
- Very good dimensional stability
- Excellent impact resistance
- Flexibility due dilution concept

Fibremod™ GB311U

Audi A4 & A5 Instrument panel carrier in Fibremod GB311U, a 30% short glass fibre PP compound specifically designed for foam injection moulding

Benefits
- Specifically designed to be processed
- Foam injection moulding
- Combines high flowability with a high stiffness/impact ratio
- High dimensional stability
- High weld strength

Fibremod™ CB201SY

NiO ES8 centre console carrier in Fibremod CB201SY a 20% carbon fibre reinforced PP compound

Benefits
- Easy processability
- Excellent mechanical performance
- Low density with effective weight saving
- Low warpage and high dimensional stability

Borealis PP foams for lightweight interior solutions

Polypropylene (PP) is used in the foam injection moulding process in a variety of industries. The automotive industry exploits the advantages of foam injection moulding in order to make lightweight parts. In addition to weight reduction, the process also enables the production of parts with increased dimensional stability (reduced warpage); higher specific bending strength; and improved acoustic and thermal insulation when compared to conventional injection moulding techniques.

Foamed Fibremod GE277AI for VW instrument panel carrier

Daplen™ EE142AI and Daplen™ EH142AI have been developed to unlock the full lightweighting potential for foamed parts that also exhibit good mechanics, high purity, and excellent surface aesthetics across a range of foaming degrees. Depending on part design and applied foaming process parameters weight savings of 5% – 15% and more can be achieved with this technology. Typical applications are interior trim parts like, tailgate claddings, trunk trims, pillar trims and others.

Best results in terms of surface quality and appearance are achieved in combination with chemical blowing agents (CBA). However, different CBA may offer similar weight reduction potential, the effect that each kind of CBA has on foam structure and finally part performance may vary widely. To achieve best results in the foam injection moulding process when using Daplen™ grades, Borealis recommends the alignment of tool design, process settings, and chemical blowing agent from the earliest stages in the development.

The process also offers more design freedom for individual automotive parts, allowing for the incorporation of weight-saving elements from the earliest stages of design. Up until now a major limitation of foam injection moulding has been the often unsatisfactory aesthetic appearance of the parts: the finished surface may exhibit streaks and smears. Through ongoing testing and the development of innovative modelling and simulation tools, Borealis can now offer solutions ensuring excellent surface aesthetics for interior automotive applications produced in the foam injection moulding process.

Additional information on processing guidelines, storage, safety and more may be found on Borealis Product Data Sheets. Please contact your Borealis Sales Representative for further support.

Solutions for interior applications

Grade	Density [kg/m³]	MFR 230 °C/ 2.16 kg [g/10 min]	Flexural modulus [MPa]	Tensile strength (50 mm/min)	Impact, charpy notched 23 °C [kJ/m²]	Impact, charpy notched –20 °C [kJ/m²]	HDT B (0.45 MPa) [°C]	Typical applications
	ISO 1183	ISO 1133	ISO 178	ISO 527-2	ISO 179/1eA	ISO 179/1eA	ISO 75-2	
Polypropylene copolymer								
BE677AI	905	14	1,450	26	8	4	100	Door panels and pockets, pillar trims
BG055AI	920	22	1,850	35	3.5	1.5	108	Air ducts, climate control housings
Polypropylene homopolymer mineral filled								
MD231U	1,050	6	2,700	36	3	1.2	125	Climate control parts
ME212U	1,050	13	3,100	32	3	1.5	120	Climate control parts, interior trims
PS65T20	1,040	23	2,700	32	3	2	110	Door inserts, claddings
MS64T20	1,070	22.5	3,200	32	2.5	1.2	120	Interior applications
MD441U	1,220	6	4,700	32	2.4	1.2	132	Structural interior parts
Polypropylene copolymer mineral filled								
MG160AI	985	22	1,950	25	7.5	3.5	110	Interior trims
ME266U	1,050	12	2,500	26	6	2.5	100	Interior trims
ME268AI	1,050	12	2,400	28	6	2.5	115	Structural interior parts
MG266AI	1,050	30	2,600	26	5	2	115	Interior trims
TPO Compounds								* tested on 3mm thick tensile bars
Daplen EG066AI	905	22	1,000	20	*30	8	83	Door panels and pockets, pillar trims
Daplen EG056AI	940	22	1,450	20	16	4	95	Door panels and pockets, pillar trims
Daplen EE001AI	960	12	1,450	20	*20	5	95	Door panels and pockets, pillar trims
Daplen EE058AI	970	12	1,600	21	*35	5	94	Dashboards, centre console, glove box, trims
Daplen EF098HP	970	20	1,800	22	*15	4	96	Dashboards, centre console, door panels, trims
Daplen EE168AI	990	12	1,750	20	25	5	97	Dashboards, door claddings
Daplen EG108AI	985	22	1,650	19	40	5.5	-	Dashboards, centre console, door panels, trims
Daplen EE121HP	1,010	13	1,800	20	15	5	101	Dashboards, door claddings
Daplen EF198HP	1,020	17	2,000	22	20	4	95	Dashboards, centre console, door panels, trims
Daplen EE142AI	1,000	12	1,800	22	40	5	102	Foamed tailgate cladding, centre console, interior trims
Daplen EH142AI	1,000	32	1,650	18	25	4	97	Foamed tailgate cladding, centre console, interior trims
Daplen EE189HP	1,000	13	1,700	20	30	4	94	Door claddings, tailgate claddings, centre console
Daplen EE250AI	1,040	13	1,850	20	25	3	94	Door cladding, glove box, seat covers
Daplen EF261AI	1,040	18	1,700	18	50	5	94	Dashboards, door claddings
Daplen EF267AI	1,040	16	2,400	27	6	2.5	105	Door panels and pockets, interior trims
Daplen EG265AI	1,040	21	1,750	17	55	5	94	Dashboards, door claddings
Natural fibre reinforced polypropylene								[1] unnotched
Fibremod NJ200AI	975	18	2,500	33	23[1]	4[1]	136	Non visible interior parts
Fibremod NJ201AI	975	23	2,150	30	32[1]	22[1]	126	Visible interior parts

Grade	Density [kg/m³]	MFR 230 °C/ 2.16 kg [g/10 min]	Flexural modulus [MPa]	Tensile strength (50 mm/min)	Impact, charpy notched 23 °C [kJ/m²]	Impact, charpy notched –20 °C [kJ/m²]	HDT B (0.45 MPa) [°C]	Typical applications
	ISO 1183	ISO 1133	ISO 178	ISO 527-2	ISO 179/1eA	ISO 179/1eA	ISO 75-2	
Short glass fibre reinforced polypropylene								
Fibremod GB205U	1,040	2	4,400	80	11	8	154	Engine covers, fans and shrouds, bumper brackets
Fibremod GE277AI	1,040	12	4,200	85	11	10	155	Instrument panel carriers, structural parts
Fibremod GB311U	1,120	2	6,200	97	11	9	159	Air filter housings, lamp housings, instrument panel carriers
Fibremod WE380HP	1,130	10	4,400	60	11	9	155	Gear housings, engine covers, structural carriers
Fibremod GD310U	1,130	10	6,200	105	10	9	162	Interior structural carriers
Fibremod GD302HP	1,140	3	5,100	65	25	15	150	Seat structures, interior structural carriers
Fibremod GD301FE	1,140	4	6,500	105	12	10	158	Pedal carriers, front-end carriers, lower bumper stiffeners
Fibremod GB477HP	1,230	2.5	9,000	127	12	11	163	Front-end carriers, gear housings, pedal carriers
Long glass fibre reinforced polypropylene								
Fibremod GB215HP	1,040	2	4,600	105	20	20	154	Instrument panel carrier, door module carrier, structural carriers
Fibremod GB303HP	1,120	2	6,500	125	20	20	165	Instrument panel carrier, door module carrier, structural carriers
Fibremod GB402HP	1,240	2	8,400	140	28	32	166	Frontend modulus, tailgate carriers, structural carriers
Fibremod GB416LF	1,240	2	9,000	170	28	-	160	Interior structural carriers
Dilution polymers for long glass fibre reinforced polypropylene								
BJ400HP	908	100	1,500	28	4	2	95	Base polymer for PP-LGF dilution
HK060AE	905	125	1,550	35	1	0.9	91	Base polymer for PP-LGF dilution
EE002AE	905	11	1,000	20	65	9	76	Base polymer for PP-LGF dilution
Carbon fibre reinforced polypropylene								
Fibremod CB201SY	1,000	8	9,700	85	7	5	-	Door module carriers, structural seat parts, engine components, tailgate carriers
Fibremod CB301SY	1,060	4	14,400	100	10	6	-	Door module carriers, structural seat parts, engine components, tailgate carriers
Fibremod CB401SY	1,140	2	16,700	100	11	7	-	Door module carriers, structural seat parts, engine components, tailgate carriers

Grade nomenclature

Daplen™ EE001AI

Pos. 1 (Polymer type)
H – Homopolymer
R – Random copolymer
B – Block copolymer
E – Elastomer modified
G – Glass fibre
C – Carbon fibre reinforced
M – Mineral filled
W – Other or combinations

Pos. 2 (MFR range)
B: > 0.8–2.5
C: > 2.5–5
D: > 5–10
E: > 10–15
F: > 15–20
G: > 20–30
H: > 30–40
J: > 40–100

Pos. 3 (Filler content)
0: 0–9%
1: 10–19%
2: 20–29%
3: 30–39%
4: 40–49%
5: 50–59%

Pos. 4-5 (Numerical index)

Pos. 6-7 (Application index)
AE: Automotive exterior
AI: Automotive interior
UB: Under the Bonnet
HP: High Performance
SY: Sustainability
SF: Short Glass Fibre
LF: Long Glass Fibre

Pos. 8 (Production Location)
B: South America
C: Asia
U: North America

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Driving tomorrow | Date of issue: September 2019

Borealis corporate boilerplate 2019 Borealis is a leading provider of innovative solutions in the fields of polyolefins, base chemicals and fertilizers. With its head office in Vienna, Austria, the company currently has more than 6,800 employees and operates in over 120 countries. Borealis generated EUR 8.3 billion in sales revenue and a net profit of EUR 906 million in 2018. Mubadala, through its holding company, owns 64% of the company, with the remaining 36% belonging to Austria-based OMV, an integrated, international oil and gas company. Borealis provides services and products to customers globally, in collaboration with Borouge, a joint venture with the Abu Dhabi National Oil Company (ADNOC) and with Baystar™, a joint venture with Total and NOVA Chemicals in Texas, USA. www.borealisgroup.com

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