# Automotive Exterior Solutions

Lightweight and premium surface appearance with less energy and improved yield

BOREALIS

بروج
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

## Lightweight

**Reducing vehicle weight with global innovation.** Borealis and Borouge are driving innovations in providing sustainable material solutions for the automotive industry. Collaborating with car manufacturers and their value chain partners, we are dedicated to deliver tangible benefits for the industry and the environment.

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

## Aesthetics

**Premium surface appearance for both painted and unpainted applications in visible parts.** Solutions are developed in line with automotive industries' specifications and requirements suitable for painted or unpainted applications or both in one product. In our portfolio there are two-step paint process solutions imposing stringent criteria on both polymer and paint, and mould-in colour solutions targeting premium not painted quality coloured surfaces.

## 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 manufacturing polyolefin for many different applications. Several of our European, Asian, North and South American plants produce specific thermoplastic polyolefin and polypropylene compounds for the automotive industry complying the same specification.

# Intelligent exterior systems and solutions

Lightweighting, electrification, connectivity, shared mobility and autonomous driving are the trends, converting tomorrows cars into an intelligent system rather than being an assembly of individual parts.

Achieving those ambitious targets requires a unique set of material properties engineered for peak performance in meeting the needs of each specific application.

## Intelligent exterior systems

- Lightweight
- Improved yield and thin wall
- Space fit by low CLTE

- Integrated systems
- Smart protection
- Radar transparency
- Durability and surface aesthetics

**Physical properties**
Thermal expansion
Impact strength
Stiffness
Density

Flowability
Cycle time
Shrinkage
Wide process window
**Processability**

**Surface quality**
Scratch resistance
A-Class surface
Metallic effect
Paintability

UV resistance
Heat resistance
Chemical resistance
**Stabilization**

- Modelling and simulation
- Automated paint robot
- Reliable and reproducible test results

- Application development
- Technical support
- Custom tailored materials

Ultimately, reliability in each particular aspect is confirmed by the reality of day-to-day and long-term performance. For robust, practical and aesthetically high performing exterior applications our PP and TPO compounds provide the strength and surface characteristics to replace metals and engineering plastic materials. Our products do so without any compromises in mechanical performance to give corrosion-free reliability throughout a vehicle's lifespan. Moreover, they enable significant weight savings and improved fuel economy.



# Committed to advanced performance

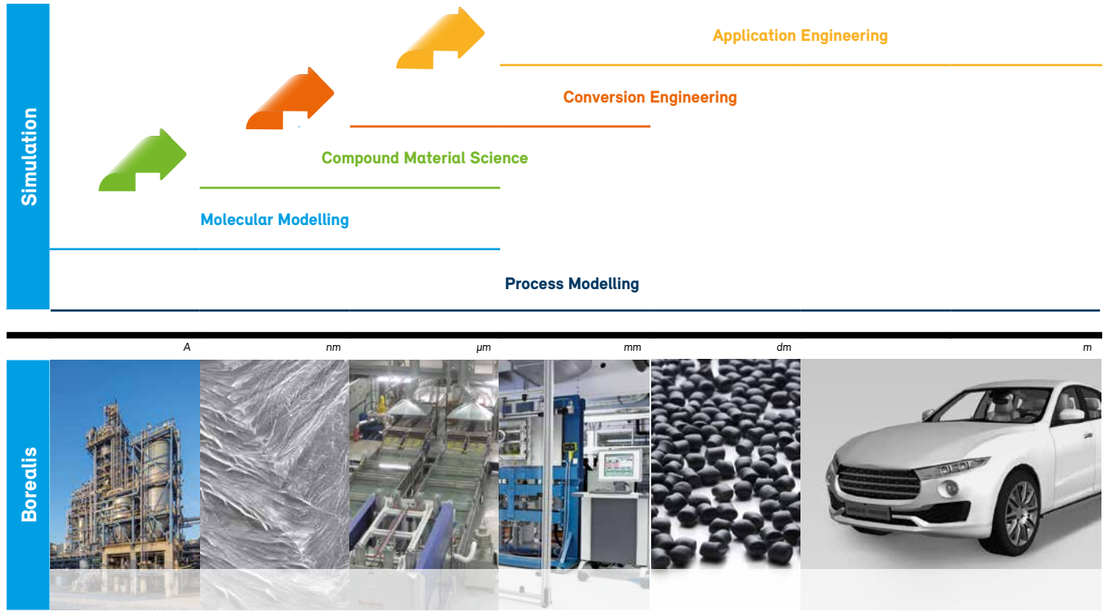
At Borealis and Borouge, we are dedicated to developing material solutions, which meet both existing and future needs of the industries we serve. This process is guided by creative innovation working with partners to identify needs before they become challenges and developing solutions that add value along the supply and production chain. To support these goals Borealis operates three world-class Innovation Centres.

Our innovation teams are engaged in the development of new materials or material improvements, as well as customer technical services ranging from part design and prototype simulation to the production and testing of batch samples and assistance with the initiation of series production. They are also tasked with the ongoing improvement of Borealis' own methodologies and processes.

**Modelling and simulation – are key differentiators of Borealis**

The maximum performance of intelligent exterior systems can only be achieved if component design, material and processing are optimally balanced. Borealis has the necessary capabilities and tools; sophisticated application testing methods and standards are developed as such comprehensive support to customers in developing and implementing applications to be moved with state of the art modelling and simulation technologies.

The objective is to cover the customer needs during prototypinging, by eliminating quality issues in the project start-up phase and reducing testing costs.



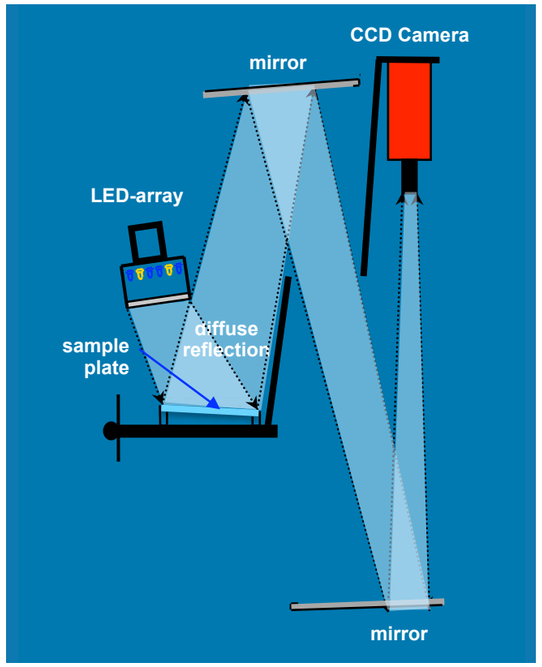
# Premium surface aesthetics

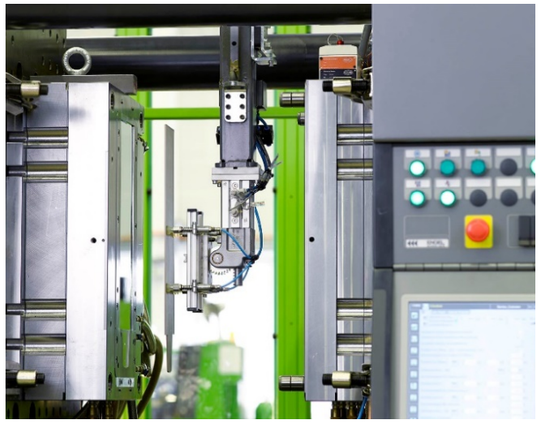
**The first interaction between people and automobiles is visual, the exterior aesthetic has a strong influence on their perceptions and purchasing decisions. Therefore, the presentation of a A-Class surface finish is essential for all automotive exterior applications whether unpainted, painted or moulded-in colour.**

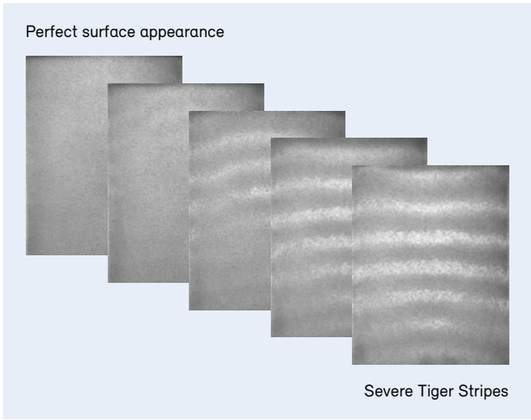
## Unpainted solutions

Flow marks, often referred to as tiger stripes, are frequently occurring surface defects in injection moulding of thermoplastic materials. They result in defective surfaces that have a negative effect on the visual quality of unpainted parts and represent a production and cost challenge for Tiers and OEMs. To address this problem Borealis has introduced a next-generation of PP compounds based on the latest Borstar technology polymers, delivering a premium surface appearance across a very broad processing window.

As we strive to enhance our portfolio of customer solutions, Borealis developed a novel test method to simulate and quantify the occurrence of tiger stripes. Borealis has subsequently developed and invested in proprietary equipment for tiger stripe testing at its Innovation Headquarters in Linz.





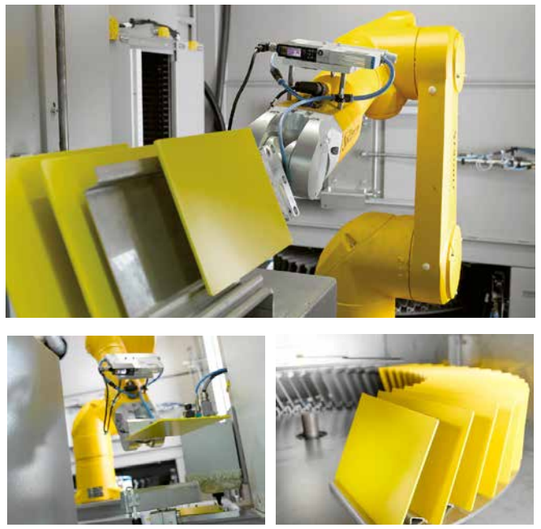

## Moulded-in colour solutions

Moulded-in colour solutions enable cost reduction through elimination of painting cycles. To co-create value in reaching their vehicle aesthetic goals, we use the expertise of our dedicated colour scientists who are working in close collaboration with pigment suppliers and developing narrow colour specifications for our PP compounds. These include simulating high quality special effects inherent to engineering plastics materials.

The Daimler Smart car is an example of one of the first breakthrough moulded-in colour solutions for body panels. Other special effect solutions include moulded-in aluminium metallic effect for stone protectors, front grills and other exterior aesthetic applications.

| So far realised colours (series and limited editions) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jack black | Rally red | Ice blue | Sunny funny | Crystal white | Light lemon | Night orange | Orange yellow |

### Primerless painting



Fully automated paint robot at Innovation Headquarters, Linz, Austria.

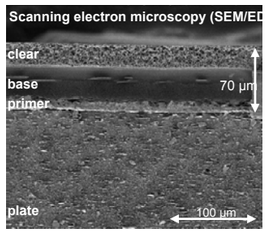
Borealis is also supporting a growing industry trend towards primerless paint systems for exterior plastic applications. Primerless painting addresses the need to reduce cycle time and system costs by eliminating production processes and moving from a 3-layer painting system to a 2-layer painting system. The 2-layer painting systems are economically attractive, however, less forgiving in terms of process fluctuations. A feature of this trend has been increasingly stringent criteria in respect of paint adhesion performance. Hence, the polymer and paint system has to be well tailored and adjusted to each other and production processes need to be reliable and robust. To help OEMs overcome this challenge, Borealis has undertaken a unique R&D initiative to develop primerless 2-layer paintable compounds for bumpers and body panels.

### Less energy consumption

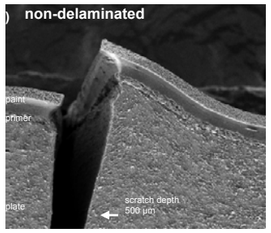
Exterior automotive parts made of plastics that are suitable for primer less painting systems reduce cycle time and system costs, enabling sustainable solutions to the industry.

### Yield improvement

By providing high flow materials with improved mechanical properties and rigidity for thin wall bumpers and other exterior parts, our main target is to increase yield and deliver lightweight without compromising on premium surface appearance.




Elemental analysis of paint and polymer substrate.




Analyses of paint and substrate deformation



# Continuing to build on success

Borealis and Borouge, working in close co-operation with Tiers, are continuously engaged in extending the possibilities of PP and TPO compounds for automotive exterior applications that meet OEMs' global specifications. These developments focus on lower density and lighter weight materials which are uncompromising in their balanced stiffness and impact performance, providing easier and lower cost manufacturing.

## Daplen™ EF150HP Daimler Group


**The second generation of lightweight PP compound for Smart bumper, side panels, tailgate and hood is also used for AMG and C-Class grills**

- Lightweight material suitable for engineering plastic replacement
- Moulded-in colour
- Excellent surface aspect for unpainted parts
- Very good scratch resistance
- High dimensional stability
- Excellent impact/stiffness balance
- Improved processability

## Daplen™ EE112AE BMW Group

**Primerless bumper and tailgate cover solutions for BMW 7 series**

- Excellent paint adhesion for two layer paint system
- Optimisation of painting cycle time and system cost
- Low density material enabling weight reduction
- Good impact and stiffness balance

## Daplen™ EG107HP Renault Group


**Global bumper solution for a broad range of Renault-Nissan models**

- Excellent surface aesthetics for both painted and unpainted parts
- Very good processing
- Weight reduction potential through thinner wall designs
- System cost optimisation

## Daplen™ EF155AE


© Volkswagen

**Lightweight bumper solution for, among others, VW Golf**

- Material combination allows both ready-to-use and open compound concept
- Reduced filler content provides lighter weight solution
- Good flowability requiring lower injection pressure, less energy input and reduced tool wear
- Low Coefficient of Linear Thermal Expansion (CLTE) for zero-gap assembly

## Open compound EF015AE + WN501AE Volvo


© Volvo Car-Group: Volvo V40 CC

**Volvo open compound painted bumpers for V40, XC60 and S60, among others**

- Close co-operation with the Tier 1 in formulation fine-tuning
- Low scrap rate
- High quality perception
- Very good paintability
- Shrinkage adaption is possible with material concept

## Daplen™ ED113AE Daimler Group

**Daimler - new bumper solution Daplen™ ED113AE**

- Excellent Daimler paint adhesion
- Suitable for Bumper and Rocker Panel
- A-Class surface
- Global Availability



# Materials portfolio for exterior applications

| Grade | Density [kg/m³] | MFR 230 °C/ 2.16 kg [g/10 min] | Flexural modulus (2 mm/min) [MPa] | Tensile strength (50 mm/min) [MPa] | Impact, charpy notched 23 °C [kJ/m²] | Impact, charpy notched -20 °C [kJ/m²] | HDT B (0.45 MPa) [°C] | CLTE (-30/+80 °C) [µm/mK] | Typical applications |
|---|---|---|---|---|---|---|---|---|---|
| **Copolymers** | | | | | | | | | |
| **Daplen™ EF015AE** | 895 | 18 | 800 | 19 | 35 | 7 | 68 | 86 | Bumpers, exterior trims |
| **Daplen™ EE002AE** | 905 | 11 | 1,000 | 20 | 65 | 9 | 76 | 100 | Bumpers, exterior trims |
| **Daplen™ EE050AE** | 905 | 11 | 950 | 20 | 60 | 10 | 75 | 100 | Bumpers, exterior trims |
| **Daplen™ KSR4525** | 905 | 7 | 970 | 20 | 50 | 7 | 70 | 100 | Bumpers, exterior trims |
| **TPO Compounds** | | | | | | | | | |
| **Daplen™ EE103AE** | 950 | 12 | 1,400 | 19 | 50 | 7 | 92 | 72 | Bumpers, exterior trims |
| **Daplen™ EF155AE** | 950 | 18 | 1,400 | 18 | 35 | 5 | 90 | 74 | Bumpers, exterior trims |
| **Daplen™ EF005AE** | 960 | 25 | 1,070 | 16 | 52 | 6 | 85 | 65 | Bumpers, exterior trims |
| **Daplen™ EH104AE** | 970 | 40 | 1,200 | 16 | 38 | 5.5 | 80 | 68 | Bumpers, grills, stone protectors |
| **Daplen™ EH119HP** | 970 | 33 | 1,450 | 17 | 50 | 6 | 97 | 67 | Bumpers, side and rocker panel |
| **Daplen™ EE112AE** | 980 | 14 | 1,500 | 18 | 65 | 12 | 95 | 56 | Bumpers, tailgate cover, exterior trims |
| **Daplen™ EF119AE** | 990 | 23 | 1,750 | 19 | 55 | 7 | 101 | 50 | Bumpers, exterior trims |
| **Daplen™ EF120AE** | 990 | 23 | 1,750 | 19 | 55 | 7 | 101 | 50 | Bumpers, exterior trims |
| **Daplen™ EG107HP** | 995 | 22 | 1,750 | 20 | 40 | 6 | 100 | 70 | Bumper, rocker panels, exterior trims |
| **Daplen™ ED113AE** | 1,000 | 8.5 | 1,830 | 17 | 35 | 5 | 102 | 66 | Bumpers, exterior trims |
| **Daplen™ EG134AE** | 1,010 | 32 | 1,620 | 18 | 40 | 4.5 | 100 | 57 | Rocker panels, exterior trims |
| **Daplen™ EF150HP** | 1,010 | 22 | 2,100 | 23 | 29 | 4.5 | 110 | 54 | Bumper, rocker panels, exterior trims |
| **Daplen™ ED213AE** | 1,020 | 8 | 1,850 | 17 | 29 | 10 | 102 | 70 | Bumper, rocker panels, front grills |
| **Daplen™ EE209AE** | 1,040 | 13 | 1,500 | 16 | 65 | 8 | 93 | 43 | Bumpers, exterior trims |
| **Daplen™ EF209AE** | 1,040 | 22 | 1,700 | 17 | 60 | 6.5 | 90 | 45 | Bumpers, exterior trims |
| **Daplen™ EF210AE** | 1,040 | 22 | 1,650 | 15 | 50 | 6.5 | 90 | 45 | Bumpers, exterior trims |
| **Daplen™ EF109AE** | 1,050 | 20 | 1,500 | 16 | 30 | 5 | 90 | 47 | Bumpers, side and rocker panel |
| **Daplen™ EH227AE** | 1,050 | 40 | 1,550 | 16 | 42 | 6 | 86 | 49 | Rocker panels, exterior trims |
| **Daplen™ EH228AE** | 1,040 | 44 | 1,600 | 17 | 25 | 4.5 | 50 | 51 | Rocker panels, exterior trims |
| **Daplen™ EF253AE** | 1,070 | 20 | 2,400 | 19 | 23 | 4.5 | 109 | 51 | Body panels, exterior trims |
| **Daplen™ EH340AE** | 1,100 | 43 | 1,900 | 18 | 12 | 2.9 | 105 | 46 | Rocker panels, side panels, grills |
| **Daplen™ EG346AE** | 1,100 | 23 | 1,950 | 18 | 25 | 5 | 93 | 47 | Bumpers, tailgate skin, exterior trims |
| **Mineral filled compounds** | | | | | | | | | |
| **Daplen™ MS64T20** | 1,070 | 22.5 | 3,200 | - | 2.5 | 1.2 | 120 | 56 | Bumpers, side & rocker panel |

| Grade | Density [kg/m³] | MFR 230 °C/ 2.16 kg [g/10 min] | Flexural modulus (2 mm/min) [MPa] | Tensile strength (50 mm/min) [MPa] | Impact, charpy notched 23 °C [kJ/m²] | Impact, charpy notched -20 °C [kJ/m²] | HDT B (0.45 MPa) [°C] | Typical applications |
|---|---|---|---|---|---|---|---|---|
| **Performance masterbatches** | | | | | | | | |
| **WN501AE** | 1,250 | - | - | - | - | - | - | used with copolymers for open compound sloutions |
| **WN503AE** | 1,340 | 13 | - | - | - | - | - | used with copolymers for open compound sloutions |
| **WN505AE** | 1,340 | 13 | - | - | - | - | - | used with copolymers for open compound sloutions |
| **Short glass fiber reinforced** | | | | | | | | |
| **Fibremod™ GB205U** | 1,040 | 2 | 4,400 | 80 | 11 | 8 | 154 | Underbody shielding, exterior trims |
| **Fibremod™ GB311U** | 1,120 | 2 | 6,200 | 97 | 11 | 9 | 159 | Headlamp housing, structural parts |
| **Fibremod™ GB477HP** | 1,230 | 2.5 | 9,000 | 130 | 12 | 11 | 162 | Headlamp bracket, structural parts |
| **Fibremod™ GD302HP** | 1,140 | 3.5 | 5,100 | 65 | 25 | 15 | 150 | Brackets, structural parts |
| **Long glass fiber reinforced** | | | | | | | | |
| **Fibremod™ GB416LF** | 1,240 | 2 | - | 170 | 28 | - | 160 | Tailgates, structural parts |

## Grade nomenclature

**Daplen EE112AE**

**Pos. 1**
**(Polymer type)**
H – Homopolymer
R – Random copolymer
B – Block copolymer
T – Terpolymer
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