



Bormed™ solutions for healthcare moulding applications



SHAPING *the* FUTURE *with* PLASTICS

About Borealis and Borouge

Borealis and Borouge are leading providers of innovative, value creating plastics solutions. With more than 40 years of experience in polyolefins and using our unique Borstar® technology, we focus on the infrastructure, automotive and advanced packaging markets across Europe, the Middle East and Asia. Our production facilities, innovation centres and service centres work with customers in more than 170 countries to provide materials that make an essential contribution to society and sustainable development. We are committed to the principles of Responsible Care® and to leading the way in 'Shaping the Future with Plastics'™.

Borealis is owned 64 % by the International Petroleum Investment Company (IPIC) of Abu Dhabi and 36 % by OMV, the Austrian oil and natural gas group. With EUR 5.7 billion revenue in sales in 2006 and 4,500 employees, the company is headquartered in Vienna and has manufacturing operations in Austria, Brazil, Belgium, Finland, Germany, Italy, Sweden and the United States. Borealis also has two innovation centres and customer service centres across Europe.

The company's main products are polyolefins and it produces also nutrients and base chemicals such as melamine, hydrocarbons, phenol and acetone.

Borouge is a joint venture established in 1998 between Borealis and one of the world's leading oil companies, the Abu Dhabi National Oil Company (ADNOC). Its headquarters, counting 830 employees, and its state-of-the-art world-scale petrochemical complex are located respectively in Abu Dhabi and Ruwais, the United Arab Emirates. Borouge is currently implementing a multi-billion dollar expansion at its Ruwais production facility. The project, called Borouge2, is due for completion in 2010 and will triple the company's polyolefin production capacity.

For more information:

www.borealisgroup.com

www.borouge.com



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ASTICS

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Adding value with Borstar

Our own proprietary Borstar polypropylene (PP) and polyethylene (PE) technologies open up possibilities to develop even more advanced polyolefin products and applications by tailoring the molecular structure to specific requirements. Our task is to set and monitor trends across the industry, understand the market needs and, in cooperation with our customers, develop the right products that provide added value for all players in the value chain.



The healthcare market

The healthcare market is strategically important for Borealis, which has long had a presence in this market segment and has acquired extensive knowledge. There is no doubt that we have the technical capabilities to match the demanding market requirements of the healthcare industry.

Since polyolefins are bulk chemicals, it could be asked whether they are the right polymers for this highly demanding industry. Borealis believes that polyolefins offer certain advantages which are essential for these applications. These include:

- Chemically inert
- Easy to shape by different conversion techniques
- Environmentally friendly
- Competitive cost/performance ratio
- Highly diversified properties
- Good water barrier

These excellent properties enable polyolefins to claim a major share in the use of polymers for healthcare applications.

Long term commitment combined with the development of new and innovative products are the cornerstones of Borealis' success. We offer a comprehensive range of polyethylene (PE) and polypropylene (PP) grades dedicated to healthcare. A grade overview is presented on page 16 of this brochure.

Global demand for plastics in healthcare applications is forecast to grow at an annual rate of 2 to 5 % in the coming years due to:

- Ageing of the population
- Population increase and emergence of new consumer markets
- Increased occurrence of life-style-linked allergic and infectious diseases worldwide
- Lack of care givers, leading to more ambulatory and home treatments
- The need for safer, smaller and more convenient packaging
- Increased awareness of staff and patient safety

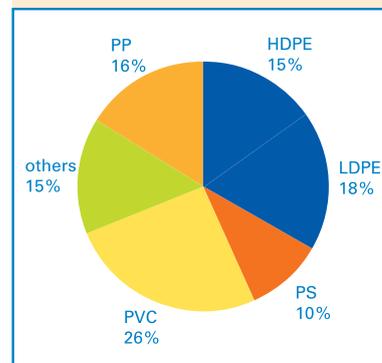


Figure 1: Polymers used in healthcare





Market segmentation

Healthcare applications are highly diversified but in the case of moulding applications, two main market segments can be identified: medical devices & pharmaceutical packaging.

Medical devices

This market segment includes several applications, each having their specific requirements. One of the best-known segments is the disposable syringe. Over the years the materials, especially polypropylene, have needed additional features to comply with market requirements:

- Radiation resistant PP
- PP with low COF
- Transparent PP
- Easy processing PP

In Europe, syringes are now competing with other dosing techniques, such as injector pens for penicillin and insulin. The growth of the latter is being spurred by the trend to self-administer medicines for chronic diseases.

In addition to these, many other medical devices such as needle hubs and Catheters, already use PP or PE. Many others, such as inhalers or housings for dialysis machines, have also recently moved to polyolefins.

Healthcare industry

Medical devices	Pharmaceuticals and diagnostics
Single use syringes	Tablets (tubes and blisters)
Pre-filled syringes	IV solutions (bottles and bags)
Transportation equipment	Diagnostic packaging (e.g. insulin)
Implants	Bottles and caps
Filters for dialysis machines	Pumps
Catheters	IM containers

Table 1

Pharmaceutical packaging

Although highly diversified, this market can be split into two main sub-segments:

Packaging for parenteral solutions

This type of packaging is mainly designed for IV solutions but it can also be used for ophthalmic solutions, drainage solutions, etc. Most of this packaging is made by Blow-Fill & Seal (BF&S) machines in a white room. The technique has the proven quality to produce sterile solutions in bottles and ampoules, but legislation is pushing towards final sterilisation which influences the choice of material.

LDPE has been the material of choice for this application for many years. However, in recent years the greater technical demand has seen PP usage steadily growing and it has now reached 25 % market share in Europe.

Pharmaceutical & diagnostic packaging

This market segment includes a wide variety of tubes, bottles and closures in many shapes colours and sizes. These articles all require the use of polyolefins with a range of specific properties that will ensure a high purity standard:

- High ESCR
- Transparency
- Sterilisation at 121°C
- Chemically inert
- Easy processability
- Balanced cost/performance ratio



Market needs

The polyolefin industry is developing fast with:

- Larger production plants
- New innovative materials

The development of a new device or drug can take many years. Compatibility testing is a time and cost consuming operation which is needed to give the patient the necessary assurance.

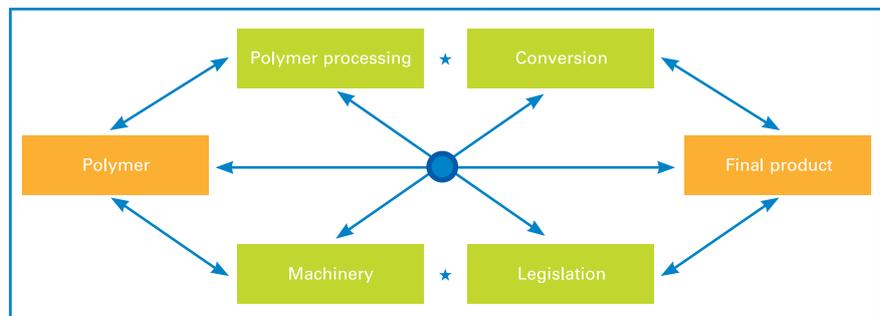
Customers in the Healthcare sector therefore expect a certain service level and a follow-up that are a notch above other market segments. They also expect their suppliers to balance a long term commitment and stability with the constant development of innovative solutions. A number of criteria are therefore important for a material used in the healthcare industry:

- Assurance of supply
 - safety stock/good planning/priority
 - continuous availability
- Quality of the grade range
- Consistency & quality (Good Manufacturing Process (GMP))
 - no contamination allowed
 - guarantee all necessary liability matters
 - traceability (International Organisation for Standardisation (ISO))
- Excellent service
- Global supply



In all market segments, every part of the value chain clearly has its importance. In healthcare applications this is even more the case and good collaboration between the different parts of the value chain is essential to success.

Figure 3: The healthcare way of working



Bormed

For over 20 years Borealis has offered dedicated healthcare polyolefins for blow fill and seal applications and syringes. Our extended product range now includes PP and HDPE for injection and blow moulding of medical devices and pharmaceutical and diagnostic packaging. Borealis has branded all its moulding materials for healthcare applications under the name Bormed.

Materials for healthcare applications have typical needs and requirements. The properties of Bormed materials are different to those of standard materials. New polymer technologies further extend the possibilities for the use of polyolefins in healthcare applications.

Delivering materials for healthcare is a major challenge regarding:

- Quality
- Liability
- Availability

Each healthcare application segment is highly differentiated and thus requires a specific set of properties. Borealis believes these requirements can only be covered with dedicated materials. Bormed is the brand name of the Borealis materials for moulding healthcare applications.

Why ?

Bormed is a range of polyolefins including PP homopolymer, PP block copolymer, PP random copolymer and HDPE which are produced and controlled under strict conditions, taking the requirements of the healthcare industry into consideration.

The Bormed range includes several materials produced with the latest technology which further enhances the properties of polyolefins. All Bormed materials are tested according to the United States Pharmacopoeia (USP) and have a Drug Master File (DMF) at the FDA. Many of these materials also fully comply with the European pharmacopoeia, Monograph 3.1.3.



Borealis aims to differentiate these materials as:

- Internally easy to recognise
 - clear & strict SOP's
 - strict QC
 - priority in production
- Easy to recognise by our customers
 - only moulding materials for healthcare
 - supported by extra liability
 - long guaranteed lifetime without change
 - available at any time





HDPE

Bimodal HDPE has superior properties compared to conventional materials. Especially in HDPE these materials demonstrate:

- Better and easier processing
- Higher ESCR (Environmental Stress Cracking Resistance)

Bormed includes two bimodal materials: Bormed HE7541PH for injection and injection blow moulding and Bormed HE2581PH for blow moulding and injection blow moulding.

Borealis believes that assuring or increasing the quality of packaging is essential in healthcare - expensive medicines should not risk being spoiled. Both materials offer increased ESCR properties; the risk of stress cracking problems on a bottle or cap is greatly reduced, resulting in higher quality packaging. If a given packaging already fulfils its needs, bimodal HDPE can make processing easier and allow downgauging, while maintaining the properties of the original packaging, resulting in a competitive advantage.

In injection moulding, Bormed HE7541PH flows like a material with MFR = 8, while in blow moulding, Bormed HE2581PH gives an increased extruder throughput of up to 15 % due to its better flow and low swell.

Bormed HE7541PH is typically used for closures, while Bormed HE2581PH is designed for bottles and containers up to 10 l. Both materials are very easy to process and possess a very high ESCR. Bormed HE2581PH is suitable for producing containers for drainage liquids and bottles for fine chemicals, pharmaceuticals and diagnostics.

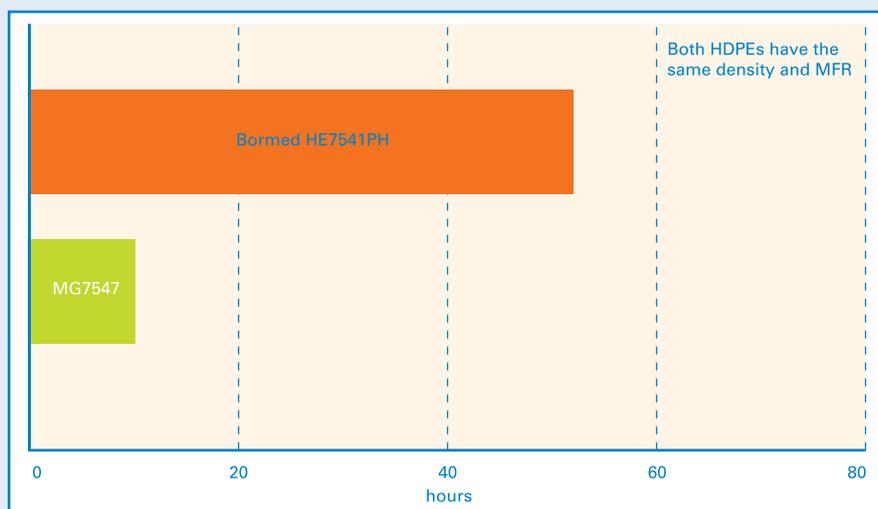
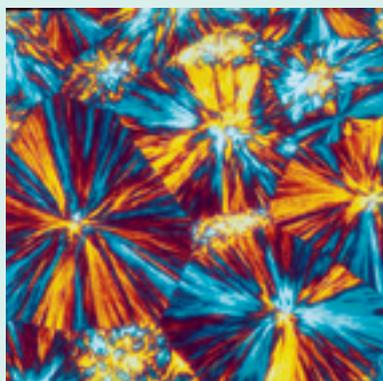
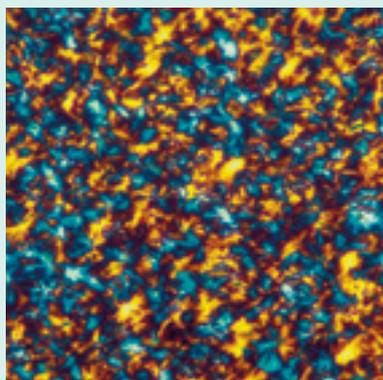


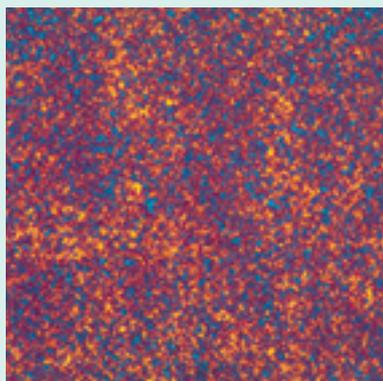
Figure 4: ESCR - Bell test



Non - nucleated PP



Talc nucleated PP



BNT

Figure 5: Spherulites of different PP's

BNT - PP

Nucleation is used to modify the properties of polypropylene. Nucleation agents are added during the pelletising step. These additives increase:

- Stiffness
- Heat distortion temperature
- Vicat softening point
- Crystallisation temperature
- Crystallisation speed
- Hardness
- Transparency

All these properties are very relevant to healthcare applications. However these agents could also cause problems when used in healthcare applications if:

- The nucleation agent is not listed on the positive list of the pharmacopoeia
- The nucleation agent causes a too high level of extractables

Borealis Nucleation Technology (BNT), a Borealis proprietary technology, offers one of the most effective nucleation methods for PP. The nucleation is done during polymerisation, so there is no need for additives while pelletising. Besides the aforementioned advantages these materials fully comply with the existing pharmacopoeia recommendations.

Bormed HD850MO is a BNT material offering these advantages. It is a homopolymer that can be used to produce containers, closures and medical devices. It has a very homogeneous morphology resulting in a very even shrinkage, leading to high dimensional stability.

Radiation resistance

Radiation sterilisation is used in an increasing number of applications. Some polymers are sensitive to degradation (formation of radicals) due to the high level of energy used. As radicals in a solid system have very little mobility, some effects of this degradation - such as brittleness - will be delayed and will only be visible after a few weeks or months.

Normal polypropylene will degrade and become brittle when irradiated. Polyethylene, on the other hand, will crosslink. Radiation at doses up to 50 kGy has very little influence on polyethylene although it can yellow strongly after radiation.

Polypropylene designed and stabilised in a proper way can withstand the radiation (25 kGy) needed for sterilisation.

Bormed HD810MO & Bormed RF830MO are, respectively, a homopolymer and a random copolymer which keep their major properties after radiation. Post-radiation testing, in normal conditions or accelerated at elevated temperatures, show that both materials are designed to be sterilised with radiation.

These materials are typically used to produce syringes. However, they also fulfil the increasing need for sterile PP products in diagnostic and pharmaceutical packaging as well as in biological & microbiological investigation and research.

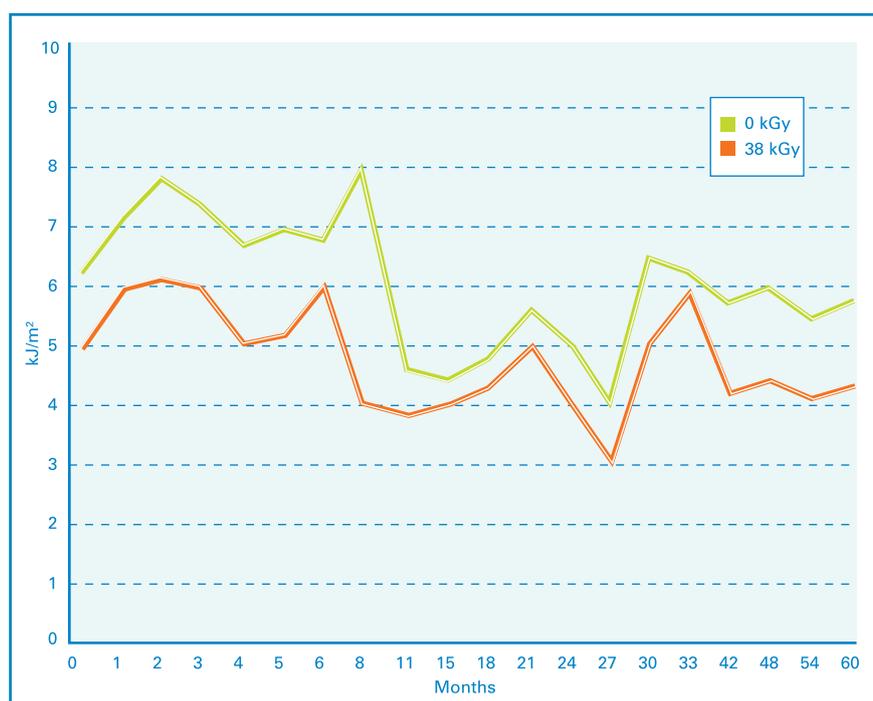


Figure 6: Charpy notched 23°C - Bormed HD810MO

Bottles and ampoules

Bormed RB845MO

Bormed RB845MO is a random polypropylene copolymer used to produce bottles and ampoules up to 1 litre. It can be used on a BF&S or on a normal blow moulding machine. It has the advantage of withstanding steam sterilisation at 121°C for 20 min.

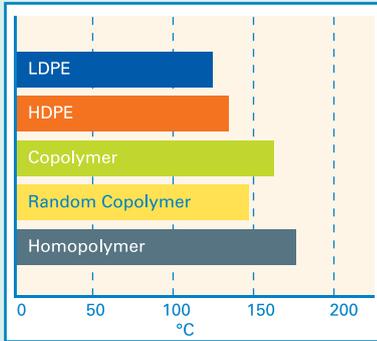


Figure 7: Melting temperature



Use of polyolefins in cold environments

In healthcare applications, refrigerator or deep freeze storage is often used. At the start of the development of a device or a packaging, consideration needs to be given to the temperature at which the product will be used or stored.

Figure 8 clearly shows that the brittle behaviour of PP homopolymer and random copolymer is already evident at low positive temperatures.

Bormed HE9621PH & Bormed BE860MO are a HDPE and a PP block copolymer respectively which show no brittle behaviour at low temperatures. Packaging produced from these materials is ideal for storage in a deep freeze or refrigerator.

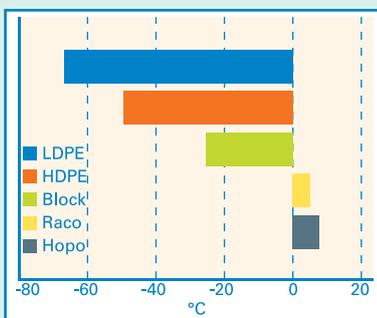


Figure 8: Embrittlement temperature

Reduced friction

Catheter valves, syringes and closures are typical products where a controlled friction is needed for the comfort of the patient. Parts produced from polypropylene demonstrate a rather high friction when a movement is made. Adding a slip agent to polypropylene can greatly reduce the coefficient of friction.

Bormed HF840MO & Bormed RG835MO both contain a slip agent to reduce the friction in assembled parts.

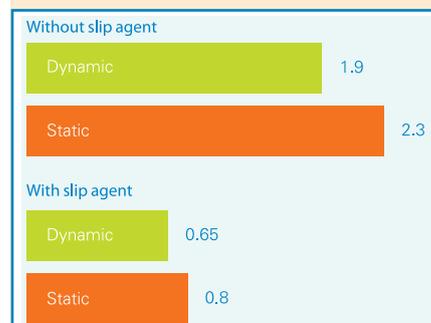


Figure 9: Coefficient of friction

Transparency

During the last decade, many clarifiers have been developed which are added to PP during pelletising. This has significantly expanded the possibilities of PP. Transparent PP can replace glass and polystyrene in many applications.

The high inertness of PP, combined with the highly improved transparency, makes new PP products possible especially in areas where optical reading is necessary.

Transparent packaging also makes it much easier for medical staff to make a final visual check on the product.

Combinations of excellent transparency with radiation resistance or reduced friction further increase the possibilities.

Bormed HD810MO, Bormed RF825MO, Bormed RF830MO and Bormed RG835MO all exhibit this high transparency.

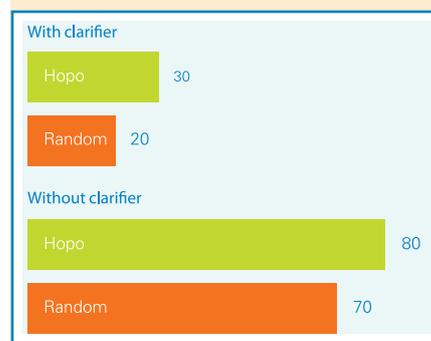


Figure 10: Haze on 2 mm thick plaques





Bormed polyolefins for healthcare moulding applications

Social security expenditure is increasing in most countries and for many reasons. Governments are making major efforts to reduce this expenditure, with mixed results. However, higher healthcare awareness and ageing populations will continue to result in an increased need for medical care. Bormed materials can help to keep pharmaceutical packaging and medical devices competitive without risks for the patient or healthcare staff due to:

- Very competitive cost/performance ratio
- Long term availability
- Environmental friendliness
- Easy processability

Borealis fully understands the very high demands on product stewardship in this ultra sensitive market and believes that using dedicated Bormed materials in the right applications with the necessary quality procedures implemented throughout the production process minimises the risk of any liability issues for Borealis and for our customers. We have always welcomed plants audits from our healthcare customers and see this as an important measure for building trust and understanding.

Polymers, including polyolefins, are still bringing better possibilities and more comfort to the patient and medical staff. There are plenty of applications using polyolefins and the requirements are very specific. Today Bormed offers a broad range of HDPE and PP for the moulding of healthcare applications. We would be very happy to discuss a new Bormed material should none of our existing products have the required properties.



Bormed polypropylene for healthcare moulding applications

Product	MFR [g/10 min]	Properties	Additional info	Main applications	EP-3.1.3 conform	USP tested	DMF no
PP homopolymer							
Bormed HD850MO	8	High HDT and good transparency	Nucleated	Pharmaceutical packaging	Yes	Yes	17929
Bormed HD810MO	10	Radiation sterilisable	Nucleated	Syringes	No	Yes	9040
Bormed HF840MO	19	Low COF	Slip agent	Syringes and closures	Yes	Yes	9040
PP block copolymer							
Bormed BE860MO	13	Very good impact		Pharmaceutical containers and closures	Yes	Yes	17930
PP random copolymer							
Bormed RB845MO	1.9	Good transparency		Ampoules and bottles	Yes	Yes	17931
Bormed RF825MO	20	Very high transparency	Nucleated	Syringes	No	Yes	12123
Bormed RF830MO	20	Very high transparency and radiation sterilisable	Nucleated	Syringes	No	Yes	12123
Bormed RG835MO	30	Very high transparency and low COF	Nucleated and slip agent	Syringes	No	Yes	12123

Test methods:
MFR (2.16 kg/230°C) = ISO 1133

Bormed polyethylene for healthcare moulding applications

Product	MFR [g/10 min]	Properties	Additional info	Main applications	EP-3.1.3 conform	USP tested	DMF no
HDPE							
Bormed HE2581PH	0.3	Very high ESCR and excellent processing		Bottles up to 10 l	Yes	Yes	18041
Bormed HE7541PH	4	High ESCR and excellent processing		Closures	Yes	Yes	18351
Bormed HE9621PH	12	Easy processing		Syringe plungers, closures and packaging	Yes	Yes	18040

Test methods:
MFR (2.16 kg/190°C) = ISO 1133

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Borstar is a registered trademark of Borealis A/S.

Bormed and Shaping the Future with Plastics are trademarks of Borealis A/S.

Borealis and Borouge Moulding specialise in supplying advanced polyolefin plastics for injection, rotational moulding and blow moulding processing technologies. Through leading technologies such as Borstar, and BNT (Borealis Nucleation Technology) and a product portfolio for a wide range of applications like bottles, thin wall packaging, caps and closures, transport packaging, houseware and healthcare, Borealis and Borouge have over 40 years established a leading position on the moulding market across Europe, the Middle East and Asia. Borealis and Borouge believe that customer-driven innovation is the only way to achieve and sustain progress. In the moulding industry, Borealis and Borouge have pioneered the development of several leading edge solutions. For example, low temperature impact; transparent polyolefins have opened up new opportunities in deep freeze display packaging. In the ISBM segment, biaxially oriented PP has reduced the weight and increased the transparency of bottles. Through foresight and focus on customer needs, Borealis and Borouge continue to provide innovative solutions for the moulding industry that add real value throughout the value chain. We know the high value that our customers in the moulding industry place on product consistency and processability. We pride ourselves on the performance of our products, and through ongoing investment in upgrades and new plant programmes, we continue to set new records for output efficiency and product reliability. Borealis and Borouge believe that responsiveness is the foundation of fruitful customer partnerships. We ensure this through the resources of strategically placed production hubs in Abu Dhabi, Austria, Belgium, Finland, Sweden and the USA; Innovation Centres in Linz (Austria) and Abu Dhabi as well as a well dispersed sales and agent network around the World.



The product(s) mentioned herein are not intended for use as medical implant material or implantable medical devices. Nothing herein shall constitute any warranty of merchantability or fitness for a particular purpose. It is the customers' responsibility to inspect and test our products in order to satisfy themselves as to the suitability of the products for the customers' particular purpose. Customers are responsible for the appropriate, safe and legal use, processing and handling of our products.

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