

Bormod™ for Modern Packaging Solutions



Borealis Film and Fibre

Borealis is a leading provider of plastics solutions. Its technology shapes daily life products and forms the basis of next generation innovation and creative product development in plastics.

The total Western European polyolefins film and fibre market exceeds 10 million tonnes per annum, with an annual growth rate of approximately 4%.

The Film and Fibre Business Unit supplies products to major converters in the application areas of film, fibre, coating, thermoforming and foam applications. Within these areas Borealis has a leading position in several key segments.

Six production sites at Beringen (Belgium), Burghausen (Germany), Kallo (Belgium), Porvoo (Finland), Rønningen (Norway), Schwechat (Austria) ensure that customers receive rapid and reliable deliveries.

Innovation centres for PP & PE are located in Linz (Austria) and Rønningen (Norway) respectively. Additional technical support activities are provided from Beringen (Belgium) and Porvoo (Finland).

Your success is our motivation

Borealis aims to provide added value beyond the customer expectations. Through interaction with our customers, and other key players in the value chain, Borealis understands the needs and future trends in the film and fibre industry.

Our products in the film and fibre area are carefully designed to meet our customers' demanding requirements, and we constantly focus on improving our products' performance in order to fulfill the needs of the whole supply chain.

This brochure profiles how we view the film and fibre market, its challenges and what we can do to help our customers' businesses become even more successful. If you have questions or require further information, please contact our sales representative in your area. See www.borealisgroup.com for contact details.



Bormod – High crystallinity PP

In May 2000, Borealis inaugurated the world's first Borstar® PP plant. This new generation process technology enables a further expansion of product properties and application possibilities.

A special feature of the Borstar PP technology is the significantly improved high crystallinity of PP grades for cast film and thermoforming applications. Based on a clear shift in impact/stiffness balance it is possible to enter into new application areas. Additionally, product economics and performance can be clearly improved in existing applications.

Borealis Bormod products represent a new generation of high crystallinity and high stiffness PP grades for cast film and thermoforming applications. These specific properties are the result of the ideal combination of the following 3 polymer parameters:

Molecular weight distribution

In general, crystallinity increases with expanded molecular weight distribution (MWD).

Higher crystallinity results in higher stiffness. The Borstar PP multi-stage process technology provides optimum flexibility in polymer design, resulting in a MWD from relatively narrow to extra broad or even bimodal.

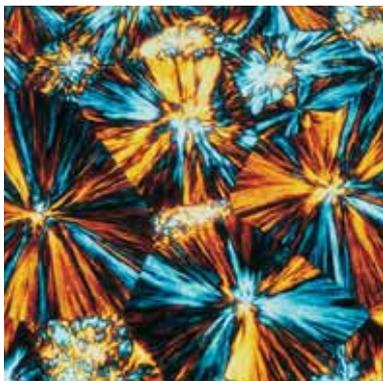
Stereo regularity

Both the absolute isotacticity (three-dimensional, symmetric arrangement of side groups) and the isotactic sequence length determine the crystallinity of homopolymers. A very high isotactic index is a distinguishing characteristic of the high crystallinity Bormod products.

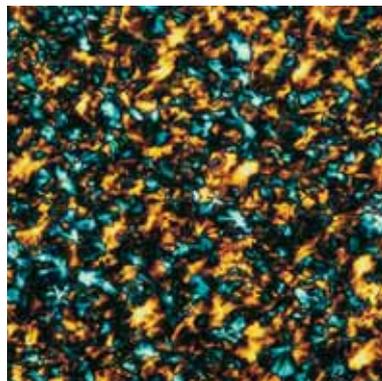
Special nucleation

The Borstar PP process takes advantage of Borealis' own proprietary nucleating technology. Specially designed for the production of PP thin films (chill roll) and thermoformed films, Bormod HD905CF + HD915CF and HC905TF homopolymers open up new fields of applications for the converter/user that could not be covered by PP until now.

Standard PP



Talcum-nucleated PP



Borealis Nucleation Technology (BNT)

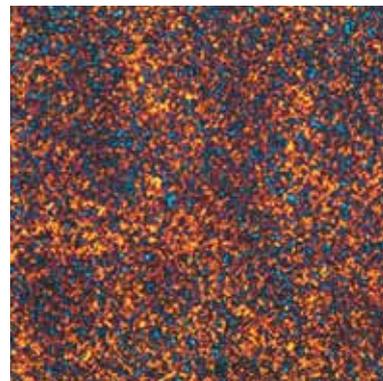


Figure 1

Crystalline structure – comparison Borstar PP versus conventional grades

Film properties of Bormod HD905CF/HD915CF

Compared with standard Borealis PP grades for chill roll films, the following properties can be achieved with Bormod (chill roll films produced in the Borealis pilot plant):

High stiffness

Benefits

- Up to 30% reduction in thickness
- No rewinding of thin cast films
- Opportunity to substitute laminates
- Access to new applications
- Twist films – label films

Good punching push-through qualities

Benefits

- Better punching properties for labels
- Improvement of push-through properties in blister system
- Easy separation of multiportion packaging (e.g. for dairy products)

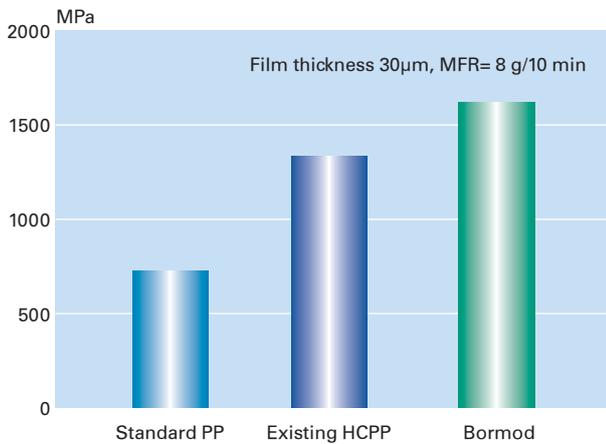


Figure 2

Young's modulus, DIN 53457

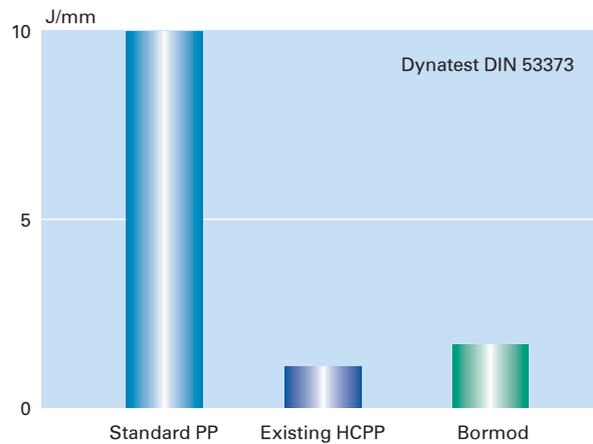


Figure 3

Penetration energy



Good processability

Benefits

- Rewinding of thin films unnecessary (e.g. for lamination applications)
- Surface improvements
 - Higher levels of pre-treatment possible
 - Slower deterioration of corona pre-treatment

Results

- Advantages in metallising and printing

- Reduction of filler content in filled film systems

Results

- Lower or no die plate-out
- Better draw-down
- Cost benefits
- Reduction in stiffness

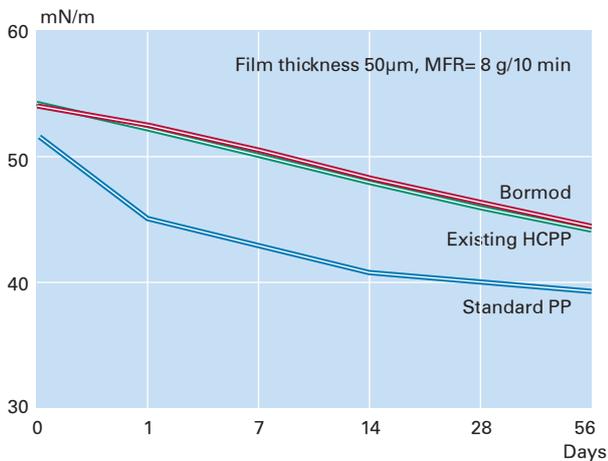


Figure 4

Corona pre-treatment

High heat deflection temperature

Benefits

- Access to hot fill applications (cheese packaging, puddings...)
- Substitution of laminates e.g. BOPP/PP cast film
- High temperature gradients achievable with coex structure

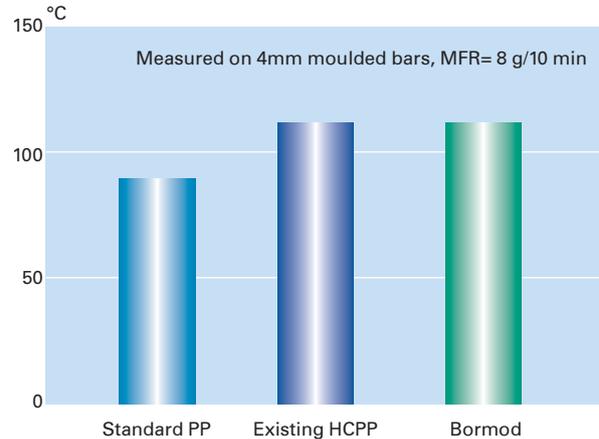


Figure 5

Heat deflection temperature, ISO 75 method B

Better water vapour barrier

Benefits

- 10–15% improved H₂O barrier increases durability and permits thinner films
- Substitution of other materials possible (e.g. PE, PVC, PS....)

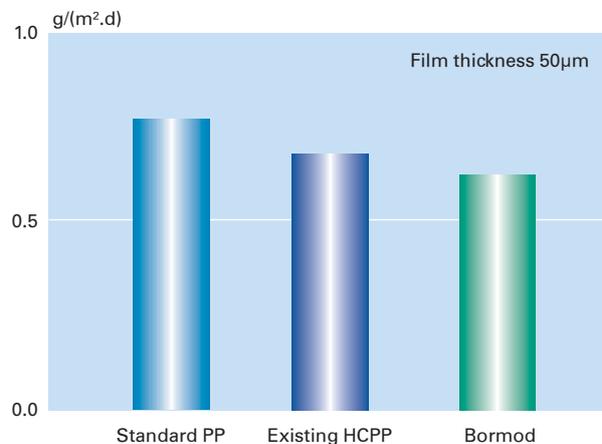


Figure 6

Water vapour permeation, DIN 53122

Bormod HD915CF for metallisable cast film

Bormod HD915CF is a high crystallinity homopolymer film resin, based on Borealis Nucleating Technology (BNT), specially developed for the manufacture of unoriented film for metallising. It is specifically designed to be coextruded as a stiff core layer with a copolymer coating layer of Borclear™ RE718CF. It is recommended to use rather high chill roll temperatures in the range of 40–55°C to obtain the optimum film stiffness. Optical properties will not deteriorate as with conventional homopolymers at these temperatures.

Bormod HD915CF is especially suitable for

- Metallisable cast film
(non migratory stabilisers/antiacids)
- Inner layer in coextrusion
- Twist films
- Labelling films
- Lamination films
- Food packaging

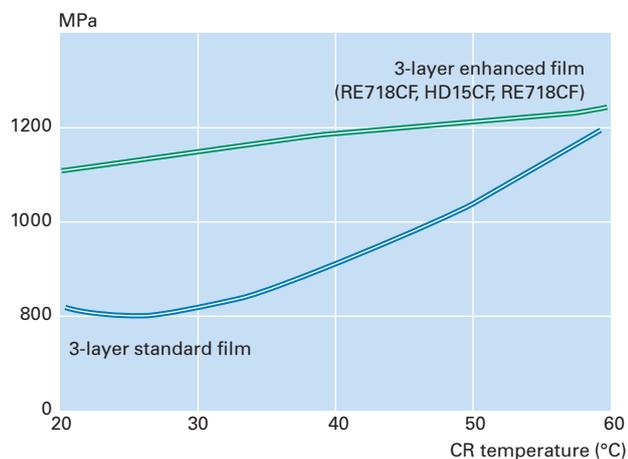


Figure 7
Stiffness

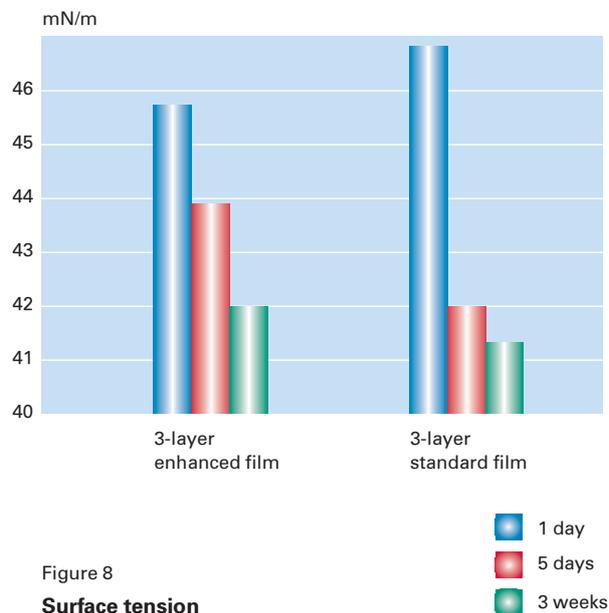


Figure 8
Surface tension

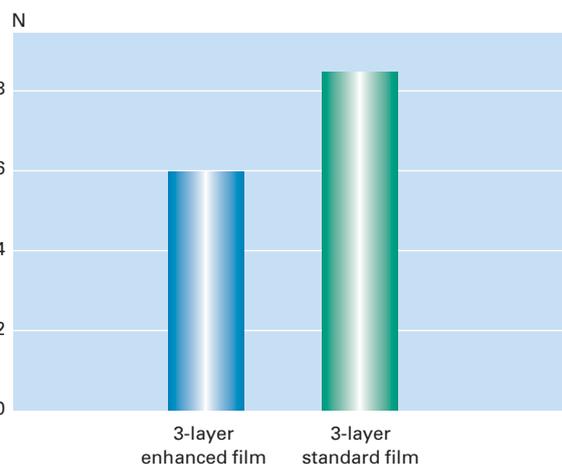


Figure 9
Blocking force

Thermoforming with Bormod HC905TF

Besides impeccable thermoformability, the most important criteria in thermoforming for the converters are a well balanced stiffness/impact ratio and perfect optical properties. By using high stiffness Bormod HC905TF, a clear shift of the impact/stiffness balance can be achieved, as well as an exceptionally high transparency and gloss. Based on higher top load values, resulting in better stackability of the thermoformed articles, a thickness reduction in the range of 10–30% can be achieved.

In addition to the savings in raw material, extra benefits can be generated from the higher output rate and reduced environmental taxes.

The recommended thermoforming applications for Bormod HC905TF are

- Thin wall articles with high clarity
- Pots and trays
- Multi-portion packaging
- Blisters
- Hot fill applications

Main benefits

- Stiffness
- Stackability
- Heat resistance
- Higher transparency
- Improved toughness

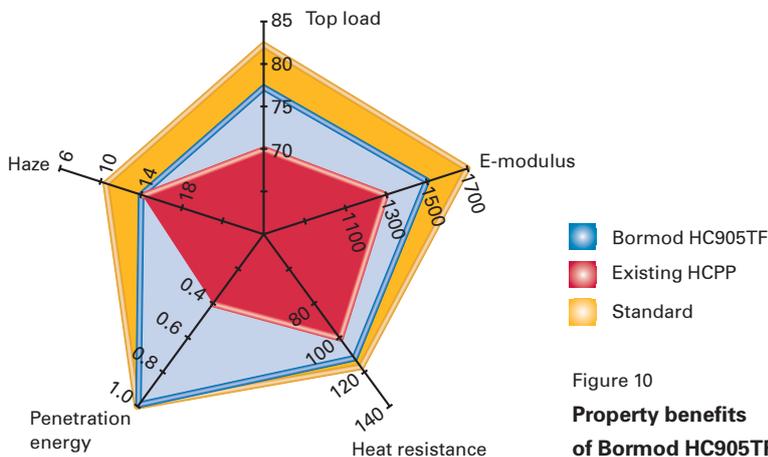


Figure 10
Property benefits of Bormod HC905TF



Processing technologies

Chill roll extrusion

To avoid the occurrence of any curling and cupping, resulting from altered crystallisation, the following processing parameters have proved to be effective:

- Melting temperature range: 220-260°C

Chill roll temperatures (both rolls)

- For mono thin films (>70µm): 30-80°C
- For mono thick films (>70µm): 70°C
- For coex films (20-150µm): 15-70°C

Production of thick films with roll stack technology

Bormod can be processed on roll stack equipment with similar adjustment parameters to those for standard PP grades. Due to the nucleation which is incorporated in Bormod grades, it is not necessary to shock cool the melt. This, in turn, results in higher production speeds and shorter dwell times on the roll stack. The temperatures on the highly polished rolls mainly depend on the thickness of the film and the haul-off speed. Generally, roll temperatures are between 60°C and 100°C. The melt temperature should be kept in the range of 240°C to 250°C.

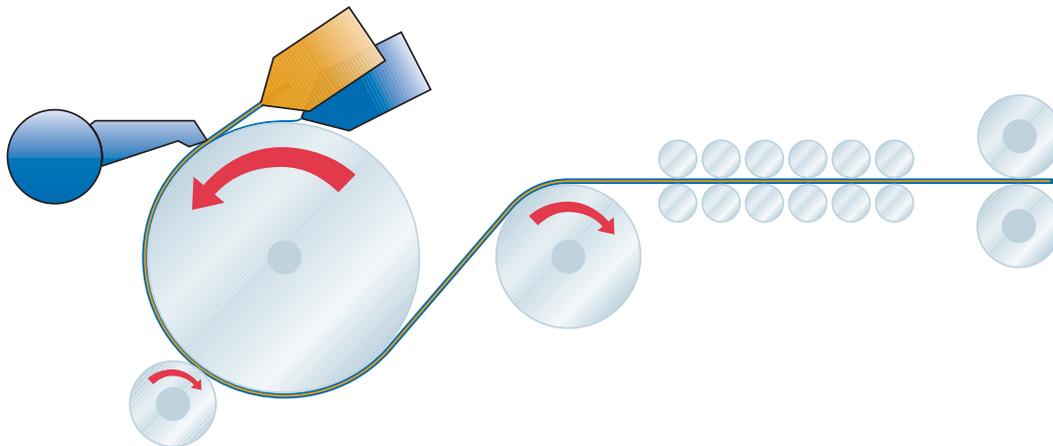


Figure 11

Chill roll extrusion

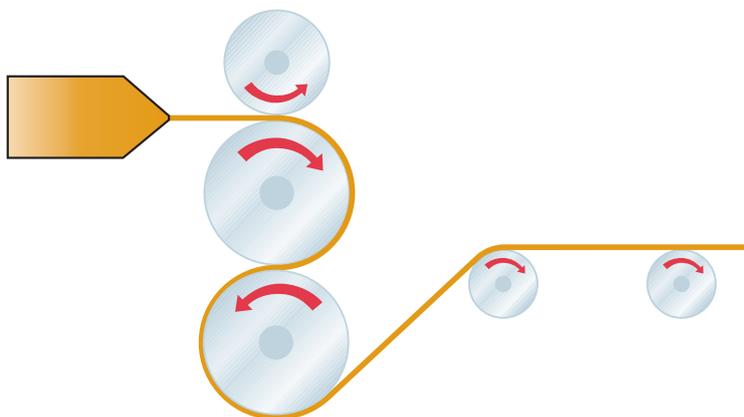


Figure 12

Roll stack technology

Bormod in coextrusion

As the high crystallinity of Bormod grades results in a relatively high and narrow transformation range - both in welding/heat sealing and in thermoforming - coextrusion in combination with other PP grades has proved to be highly advantageous.

Typical structures

- As a heat resistant external layer (Figure 13.1)
- As a transparent, high stiffness film (Figure 13.2)
- As a high stiffness, high transparency film with good sealability (Figure 13.3)
- As a freeze resistant film (Figure 13.4)

Homo = PP homopolymer
 Raco = C₂/C₃ random copolymer
 Heco = C₂/C₃ heterophasic copolymer
 Borsoft = C₂/C₃ random heterophasic copolymer

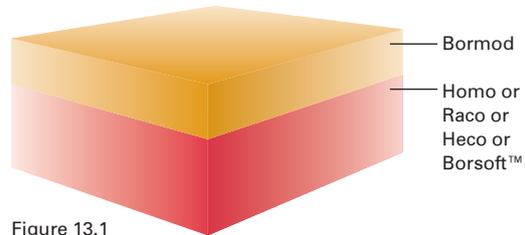


Figure 13.1

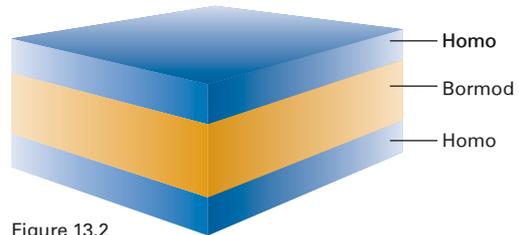


Figure 13.2

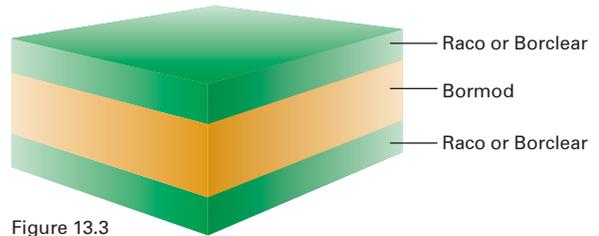


Figure 13.3

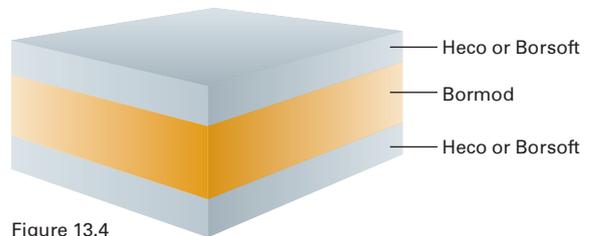


Figure 13.4

Figure 13
Typical structures

Cost benefits

Reduction in film thickness

- 10–30% is possible
- Saves material costs
 - Saves recycling costs

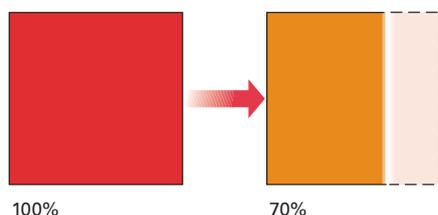


Figure 14

Saves rewinding

- No longer necessary to rewind thin chill roll films due to excellent stiffness and flatness.

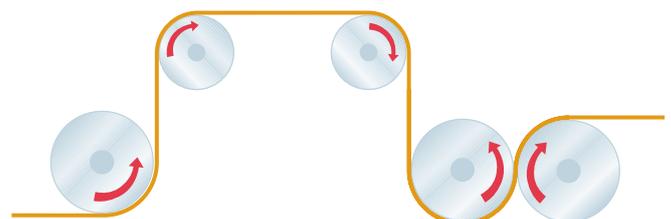


Figure 15

Advantages in terms of costs and properties

Reduction of filler content in compounds

- Higher output achievable
- Less plate-out
- Better draw-down with comparable mechanical properties

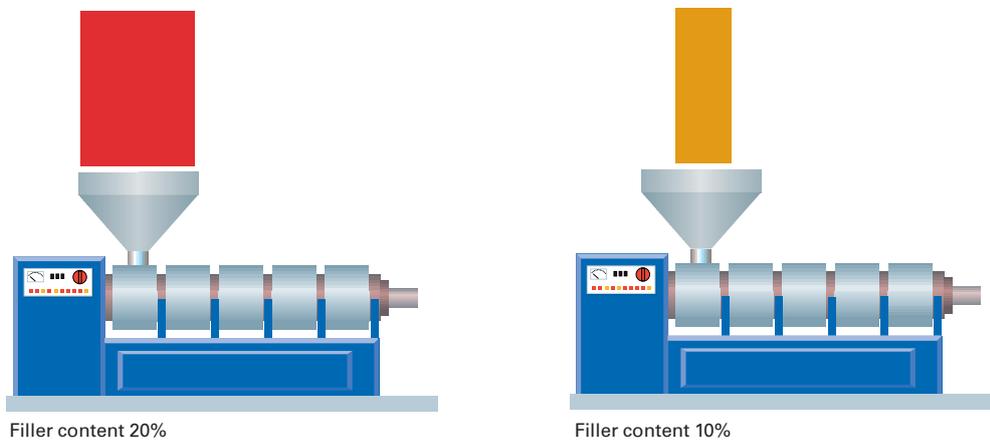


Figure 16

Higher heat deflection temperature

- Hot filling possible (PET substitute)
- Peel film applications (temperature gradient)

Substitution for laminates

e.g. substitution of BOPP / cast PP laminates by coex-film Bormod / cast PP

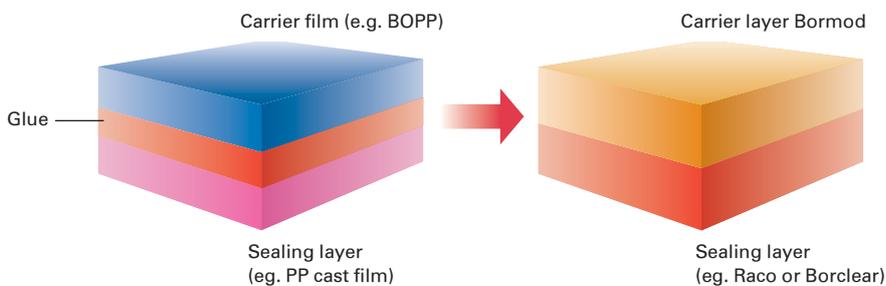


Figure 17

Physical properties*

Property	Bormod HD905CF ¹	Bormod HD915CF ¹	Bormod HC905TF ²	Unit	Test method
Density	900–910	900–910	900–910	kg/m ³	ISO 1183
Melt flow rate (230°C, 2.16 kg)	8	8	4	g/10 min	ISO 1133
Melting range	164–170	164–170	164–170	°C	ISO 3146
Flexural modulus**	2100	2100	2000	MPa	ISO 178
Vicat softening point A**	158	158	158	°C	ISO 306
Heat deflection temperature B**	118	118	115	°C	ISO 75

Film properties*

Property	Bormod HD905CF ³	Bormod HD915CF ³	Bormod HC905TF ⁴	Unit	Test method
Gloss	> 90	> 90	> 125	%	ASTM D1003
Haze	< 6	< 6	< 10	%	ASTM D1003
Tensile strength at MD/TD	45/40	45/40	-/-	MPa	ISO 527-3
Strain at break MD/TD	80/120	80/120	-/-	%	ISO 527-3
Tensile stress at yield MD/TD	-/-	-/-	38/36	MPa	ISO 527-2
Tensile strain at yield MD/TD	-/-	-/-	8/7.5	%	ISO 527-2
Tensile modulus MD/TD	1600/1800	1600/1800	1500/1700	MPa	ISO 527-3
Dynatest – damaging force	600	600	-	N/mm	ISO 7765-2
Dynatest – penetration energy	1.8	1.8	-	J/mm	ISO 7765-2
Coefficient of friction (film/film)	0.3	0.3	-	-	ISO 1295

* Data should not be used for specification work.

** Measured on injection moulded specimen conditioned at 23°C and 50% relative humidity.

- ¹ **Bormod HD905CF** Twist, labelling, stationery, hot fill, laminating
¹ **Bormod HD915CF** Twist, labelling, stationery, hot fill, laminating, metallisable
² **Bormod HC905TF** Thin wall, pots and trays, blisters, multi portion packaging

³ Specific film values evaluated on chill roll film with a thickness of 50 µm, which were produced under standard internal conditions. In comparison with films, which were produced under different conditions, it should be taken into account that the film properties are highly dependent on manufacturing conditions.

⁴ Specific film values evaluated on roll stack films with a thickness of 300 µm, which were produced under standard internal conditions.

MD = Machine direction
 TD = Transverse direction

Borealis - a leading, innovative plastics provider

Borealis is a leading provider of plastics solutions. Its technology shapes daily life products and forms the basis of next generation innovation and creative product development in plastics.

With EUR 4 billion revenue in sales and 5,000 employees, Borealis has more than 40 years of experience as a reliable supplier of polyethylene (PE) and polypropylene (PP) products. Borealis today is a partner to its customers manufacturing and developing products such as food packaging, diapers, appliances, automotive parts, distribution pipes for water, gas and sewage, power cables, sporting equipment and medical devices.

Borealis is headquartered in Copenhagen, Denmark with innovation centres, customer service centres, and main production sites in Europe and the Middle East. Borealis has representative offices and operations in Asia, North and South America.

At its heart, the company's four values of Responsibility, Respect, Exceed and Nimblicity™, define its way of doing business. For Borealis, success is driven by innovation, responsiveness, and operational excellence.

Borstar is the proprietary process technology supporting differentiated PE and PP products and is a registered trademark of Borealis A/S, Denmark.

To learn more about Borealis visit www.borealisgroup.com

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