



BorLite

A new standard in flexible packaging solutions



SHAPING *the* FUTURE *with* PLASTICS



About Borealis and Borouge

Borealis is a leading provider of chemical and innovative plastics solutions that create value for society. With sales of EUR 4.7 billion in 2009, customers in over 120 countries, and 5,200 employees worldwide, Borealis is owned 64% by the International Petroleum Investment Company (IPIC) of Abu Dhabi and 36% by OMV, the leading energy group in the European growth belt. Borealis is headquartered in Vienna, Austria, and has production locations, innovation centres and customer service centres across Europe and the Americas.

Through Borouge, a joint venture between Borealis and the Abu Dhabi National Oil Company (ADNOC), one of the world's major oil and gas companies, the company's footprint reaches out to the Middle East, Asia Pacific, the Indian sub-continent and Africa. Established in 1998, Borouge employs approximately 1,600 people, has customers in more than 50 countries and its headquarters are in Abu Dhabi in the UAE and Singapore.

Building on Borealis' unique Borstar® technology and their experience in polyolefins of more than 50 years, Borealis and Borouge provide innovative, value creating plastics solutions for the infrastructure (pipe systems and power and communi-

cation cables), automotive and advanced packaging markets. In addition, Borealis offers a wide range of base chemicals from melamine and plant nutrients to phenol and acetone.

Today, Borealis and Borouge have a manufacturing capacity of over 5.4 million tonnes of polyolefins (polyethylene and polypropylene) per year of which 26% are the result of a recently completed capacity expansion in Abu Dhabi. An additional 2.5 million tonnes per year is scheduled for completion by the end of 2013, creating the world's largest integrated polyolefins plant. The companies continue to invest to ensure that their customers throughout the value chain, around the world, can always rely on superior products and security of supply.

Borealis and Borouge are committed to the principles of Responsible Care® and proactively contribute to addressing the world's water and sanitation challenges through their Water for the World™ initiative.

For more information:
www.borealisgroup.com
www.borouge.com

BorLite- A new standard in flexible packaging solutions



Contents

- 04 BorLite™ – A new standard in flexible packaging solutions
- 06 Hosokawa Alpine AG - MDO technology
- 08 BorLite™ – Support package for application solution development
- 10 BorLite™ – Product family
- 12 Shipping sack films
- 17 Compression packaging films
- 18 High stiffness films for lamination



BorLite™ – A new standard in flexible packaging solutions

The industry seeks relevant answers to some fundamental trends, especially in an increasingly competitive business environment where the need to create sustainable long-term value is key, and the need to have a responsible and proactive attitude towards the planet and environmental protection are no longer merely considered optional programs. (or you could say: are no longer considered “nice to haves.”

Faced with these challenges, Borealis actively seeks to create value through sustainable innovative solutions.

Together with our Borstar LLD bimodal technology, we have recognised the potential to meet these challenges with MDO processing technology.

Borealis developed a specific Borstar LLD bimodal grade range, BorLite™, that, together with MDO, allows the flexible packaging market to achieve some of its more challenging and urgent needs; step change downgauging, value generation across the value chain and environmentally sustainable packaging innovations.

BorLite™ offers advanced flexible packaging film solutions, giving our value chain partners a competitive edge in high-performance packaging solutions, sustainable value generation and cutting-edge environmental solutions.





Hosokawa Alpine AG – MDO technology

MDO (Machine Direction Orientation) is used to improve many film properties such as barrier, optics, stiffness, tensile strength, tear resistance, shrink, flatness and, in case of usage of inorganic fillers, porosity. It offers substantial material cost savings by down gauging film thickness while maintaining or improving film performance. Both, crystalline and amorphous regions in the film are oriented during the process, leading to the enhanced film properties.

Due to their flatness and stiffness, MDO films run much faster in downstream converting machinery and therefore add even more value. Thick polyolefin films are produced on conventional blown or cast film lines. The downstream orientation process can be in- or offline. The film is heated up to orientation temperature and then mechanically stretched in machine direction at the desired draw ratio in order to reach the final film thickness.

Subsequently, the film is annealed by holding it under controlled temperature and tension for a given time period to ensure dimensional stability during further conversion or use. As a final step, the film is cooled down to near ambient temperature before winding.

The MDO process is a reliable and simple way to modify the properties of films and save resources. The economy of process has been remarkably improved by a newly developed optimizing system (patent pending) capable of reducing the process-related edge trim by as much as 50% and at the same enhancing the film performance.



HOSOKAWA ALPINE

BorLite™ – support package for application solution development

Borealis' major strength is the customer-focused organisation and market-driven product development, acting as an industrial partner with customers to fully understand the value chain requirements and together develop innovative products and application solutions for the flexible packaging market.

Borealis has a long tradition of providing differentiated products for many industries with high quality, consistency and reliability. This is a result of a high level of technical expertise and competencies. But just as important is the cooperation with customers and other market leaders in application developments, which has brought numerous success stories. This is facilitated by well-equipped application facilities and a network of industry contacts.



To continue supporting the industry in the development of MDO advanced packaging solutions, BorLite™ stands not only as a product brand, but has a support package for application solution development comprising:

- Tailor-made PE product range – BorLite™;
- Extended PO product range complementing BorLite™;
- Application development know-how for MDO supported by industrial-scale MDO line;
- Cost and benefit analysis know-how, supporting key decision criteria, accessing investment opportunity and project risk;
- Scale up development support.

Office building
Application Hall
Bench scale reaction
Lab services

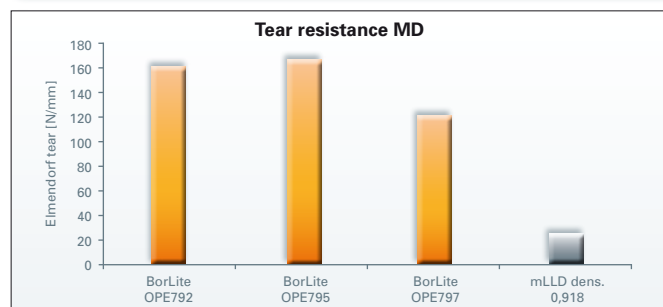
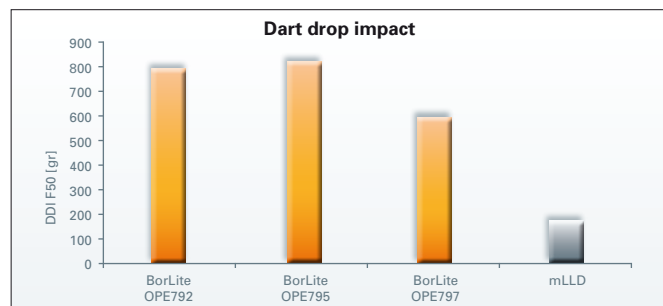


BorLite™ – product family

The BorLite™ product family is characterised by setting a new standard in performance for MDO films, offering:

- High tear resistance in MD and TD
- High puncture resistance
- High impact strength

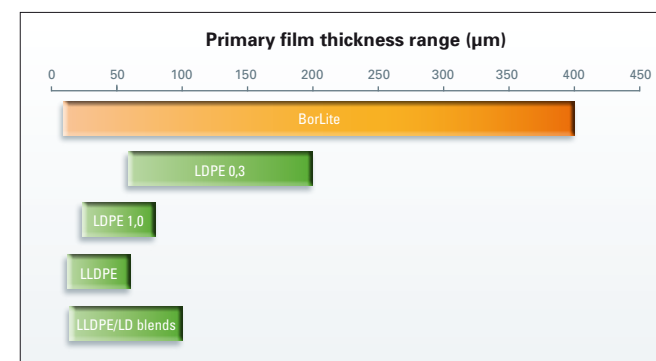
High toughness (more than 20 g/µm) coupled with excellent tear resistance in MD



Combined with the recognised set of properties achievable with MDO films:

- Very high MD tensile strength
- No elongation on MD direction
- High stiffness levels
- Transparency and gloss

Despite the fact that BorLite™ offers superior film performance, Borealis development efforts are also focused on assuring excellent processability behaviour in both blown film and MDO steps. BorLite™ exhibits very good performance in the production of the thick primary film, mostly due to its bimodal characteristics, offering high melt strength, very good bubble stability, low gel level and no melt fracture. These are critical properties when very good film quality is needed at a thickness that may exceed 150 µm most of the time.



In the MDO process, BorLite™ offers a smooth and trouble-free operation with an easy set-up of the optimal processing conditions and wide window of draw ratios, providing the needed flexibility to tailor the important properties such as stiffness, tear resistance and impact strength.

To meet the different market needs, three different grades are offered:

- BorLite™ OPE792
- BorLite™ OPE795
- BorLite™ OPE797



BorLite™ performance characteristics:

Placeholder
glue pointPlaceholder
lucid
glue point

	BorLite™ OPE792	BorLite™ OPE795	BorLite™ OPE797
E-Modulus MD (MPa)	900	900	950
E-Modulus TD (MPa)	900	950	1300
Impact strength (g/μm)	>20	>20	>20
Puncture resistance (J/mm)	44	31	41
Tear resistance MD (N/mm)	160	160	117
Haze (%)	14	14	18
Tensile strength MD(MPa)	170	190	245
Tensile strength TD(MPa)	19	21	35

Application examples of MDO films

Shipping sack films

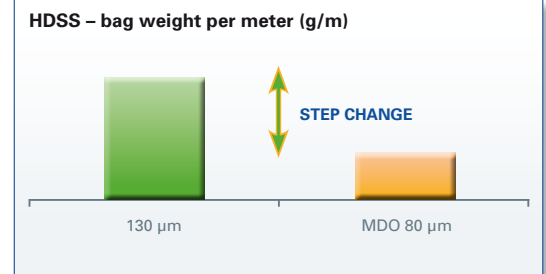
Shipping sacks for packaging of industrial products like polymers, fertilisers or minerals call for very demanding specifications of the film's mechanical performance. The industry itself is also very concerned about operational costs, including the cost of packaging.

This has resulted in a strong demand for thinner films, which use less material in order to save costs.

As a demanding proving ground for this technology combination, BorLite and MDO, we have chosen the heavy-duty shipping sacks (HDSS) area.

Film toughness, machine direction tear, creep and sealing are key properties. The new BorLite™ HDSS MDO packaging solution meets and even exceeds the standards in this market, presenting a step change vs. the current solutions.

A detailed concept development was carried out involving all elements in the value chain, from the film producer to the end user, resulting in a completely successful acceptance of the concept at all levels.



From concept...

- Step change downgauging, from 130 µm to 80µm.
38% thickness reduction.

... to film performance evaluation....

- Same or higher performance at the key film parameters
- 50% increase in impact strength
- Tear resistance in MD maintained



— Bor Lite 80µm
— Specification 130µm

... to packaging process performance...

- High packaging speed (> 2000 bags/hour) achieved
- Concept validated at the leading HDSS packaging machine manufacturers



Packaging trials

High speed packaging trials (>2000 bags/hour)

... to packaging performance...

- High load security during transport and storage.



Stacking trials

Stacking trials - 3 levels high

... to quantification of value generation...

- Reduction of bag cost per unit;

... to quantification of the environmental impacts.

- Highly positive environmental impact:
 - o 37% weight reduction in packaging use;
 - o 8% reduction on energy usage to produce a unit bag for 25 kg;
 - o 130 tons of CO2 emission reduction per 1,000 tons of goods packed.



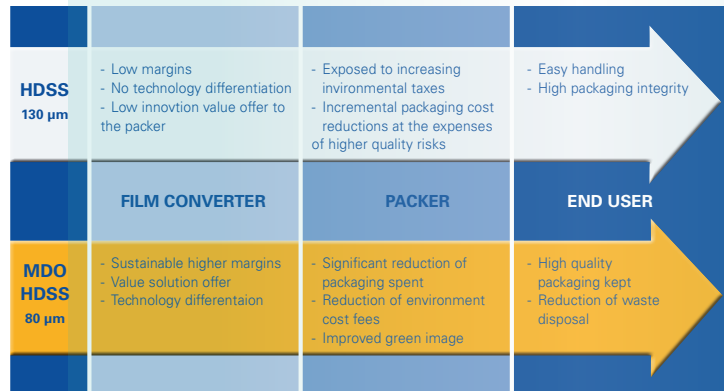
Delivery trials

transportation trial over long distance (>2500km)



Resulting in:

MDO HDSS approved by Borealis material handling department as the preferred packaging method, being in use at several of Borealis HDSS packaging lines. In summary the MDO HDSS solution offers the following benefits over the existing market solutions.



Film recipe:

A	BorLite™ OPE 792	sealing, toughness
B	BorLite™ OPE 795	stiffness, toughness
C	Blocking layer	(e.g. EMA or EVA with high concentration of co-monomer)

Primary film = 480 µm (blocked film 240 µm x 2)
 Stretch ratio = 1:6
 MDO HDSS film = 80 µm

The HDSS MDO development is one example where 'BorLite – support package' approach, working in close contact with industry, establishing partnerships with the value chain key players resulted in a successful development.

The following sections will give some more selected examples where the BorLite – support package concept aims at giving the industry an answer to their needs.

Compression packaging films

Voluminous products such as insulation materials and mattresses are normally packed in a compressed form in order to save space and transport costs. An OPE film is very well suited to this due to its extremely good creep resistance in MD. When produced from BorLite™, the film will also provide high toughness and security during transport and handling.

Film recipe:

A	BorLite™ OPE 792
B	BorLite™ OPE 795
C	Blocking layer

Draw ratio = 1:5.5
 Film thickness = 45 µm
 Comparison 55 µm coex blown film



BENEFITS:

- High impact strength
- Very good creep resistance
- Appropriate sealing
- Good tear resistance

High stiffness films for demanding applications, such as lamination, labels and twist wrap

The following MDO film solution is just one example of the potential behind the combination of the Borealis-wide PO portfolio with BorLite.

MDO films are known for their potential to easily achieve very high stiffness. Optimising the formulation, it is furthermore possible to achieve a high gloss film with excellent transparency. The perfect match in such a film happens when high toughness and good tear properties can be manipulated to a desired level, which is possible with BorLite.

To illustrate this, the example below of an MDO film based on a coextruded film with a specific Borealis HDPE grade as surface layers and a core layer of BorLite™ provides a new dimension of optical properties combined with excellent toughness and very high stiffness.

These films are very well suited for stiff film solutions such as lamination, labels and twist wrap, where a combination of toughness, high planarity, good display properties and dead fold properties are required.

Film recipe:

A	BorLite™ OPE 792
B	BorLite™ OPE 795
C	Blocking layer

Draw ratio = 1:6

Film thickness = 40 µm



BENEFITS:

- **Very good display properties (high gloss and low haze)**
- **Good printability**
- **Very good planarity (high stiffness)**
- **Good tear resistance**
- **High puncture resistance**
- **Recyclable – 100% PE solution**
- **Good twist retention**

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