

Film

Barrier Packaging



Akulon[®]

a **DSM**Guide

Unlimited. **DSM**

Packaging solutions that create added value

With a comprehensive portfolio of state-of-the-art products, DSM Engineering Plastics is a world leader in performance materials and a specialist in barrier and specialty films. Our products are based on in-depth application and process knowledge. We are dedicated to 'extending the performance envelope', with innovations that focus on adding value to our customers' applications through demonstrable gains in productivity, process performance and end-product quality.

Next to quality in products and processes, we have a strong focus on logistics and customer support. We are a partner for our customers in maximizing their productivity and market success, and in solving technical challenges through true co-makership.

As a global supplier we have a worldwide presence with manufacturing facilities around the world. That means we can supply products wherever they are needed, backed up by responsive, local customer support with a proactive account management approach.

Akulon® PA6: high consistency for optimum process performance

The highest possible oxygen barrier to keep foods fresher for longer, with excellent processability for cost-effective production.

Akulon® XP: maximizes productivity of multilayer and extrusion coating lines

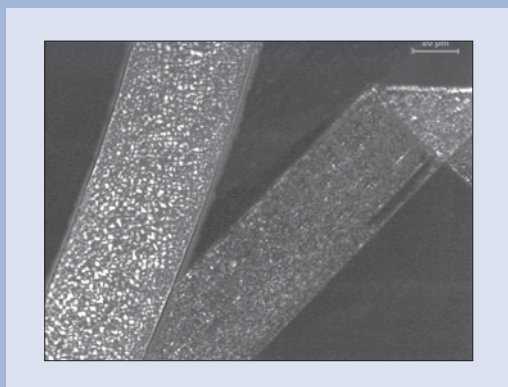
Substantial gains in line efficiency, translating directly into higher productivity and lower costs in all co-extrusion processes.

Yparex®: cost-optimized tie layers

High-performance tie layers that ensure optimal adhesion and process characteristics on multilayer extrusion lines.

Monolayer film applications that create added value

How specialty film products from DSM add value to a wide range of innovative applications in packaging and other areas.



Nucleated Akulon® PA6 film (right) shows finer, denser crystalline structure compared to un-nucleated (left).

High consistency for optimum process performance

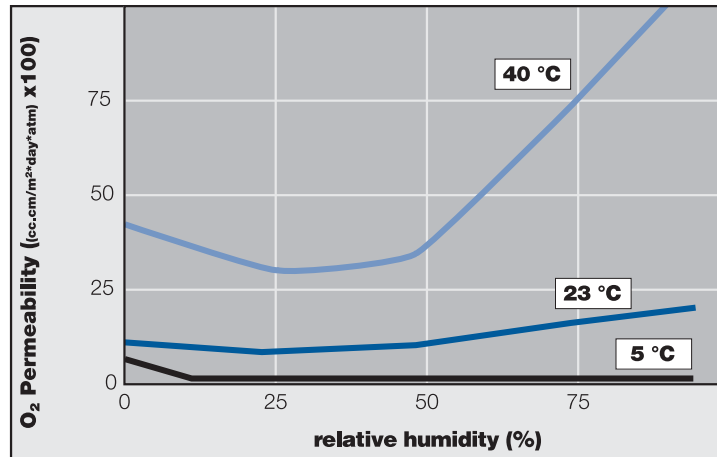
As a barrier food packaging film, Akulon[®] PA6 resins act as a barrier for oxygen and aroma, providing high mechanical strength and puncture resistance with a printable film. Akulon[®] PA6 offers a higher oxygen barrier than any other polyamide film, protecting fresh foods against activity that can lead to aging and discoloring. At the same time it has a low gel count and excellent transparency.

Optimum productivity in BOPA, monolayer and multilayer processes

DSM is one of the world's leading caprolactam producers, delivering PA6 monomer of the highest possible quality. The product range ensures optimum productivity and top quality on all lines, including biaxially oriented (BOPA) processes as well as monolayer and multilayer constructions. This makes Akulon[®] PA6 an outstanding choice for demanding, high-speed, high-volume co-extrusion and extrusion applications. Thanks to its high oxygen barrier polyamide gives excellent results when used in multilayer systems with polyethylene or polypropylene, which have relatively high oxygen permeability. These constructions are ideally suited for food packaging.

Providing the highest consistency in quality and viscosity

Making a major contribution to its high process performance, Akulon[®] PA6 offers the highest possible consistency in quality and viscosity on the market today, both within batch and batch-to-batch. This consistency ensures trouble-free production with optimum machine utilization, together with the highest end-product quality.



This graph shows how the oxygen permeability of Akulon[®] PA6 increases with temperature and relative humidity.

Comparison of barrier properties.

Permeant	Unit	PA6	LDPE	HDPE
oxygen (dry)	cm ³ *mm/m ² *day*atm	1.1-1.3	80-180	40-80
oxygen, 85% RH	cm ³ *mm/m ² *day*atm	1.6-1.8	80-180	40-80
water vapour	gr*mm/m ² *day	1.5-1.7	0.4-0.6	0.1-0.2

Akulon[®] PA6: optimum productivity and quality

Crystallization level largely determines the physical properties of PA film, including barrier properties which increase with crystallinity. Film crystallinity can be influenced by:

- processing parameters such as film thickness and chill-roll temperature
- the presence of nucleating agents such as microtalc, which increases the number of crystals.

Crystallization can also be (temporarily) suppressed, because low-crystallinity films are easier to thermoform or stretch. Further crystallization during thermoforming means the end-product will have the same excellent properties as nucleated grades. Our service engineers can advise on the best way to manage crystallinity for any specific application. Processing is further aided by carefully selected lubricants, which provide stable extruder output for high stretch ratios and low surface friction.

PA6 gives high mechanical strength

The high mechanical strength of polyamide films is the key to numerous successful applications. These properties depend strongly on the film morphology, which is determined by the film production process. Typical properties of Akulon[®] PA6 film grades are:

- Tensile strength at 500 mm/min.: 96 MPa
- Tear resistance (Trouser test): 23-28 kN/m
- Puncture resistance: 1250 J/m

Akulon® XP

Maximizes productivity of multilayer co-extrusion and extrusion coating lines

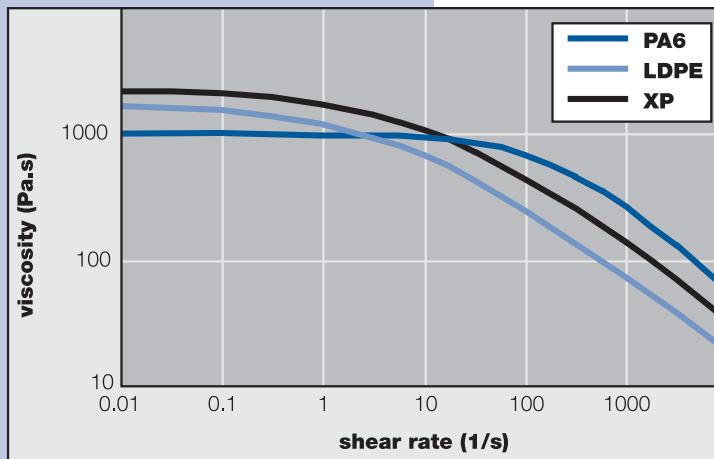
Akulon®XP from DSM enables producers to achieve substantial gains in line efficiency, which translates directly into higher productivity and lower costs. These benefits apply to all co-extrusion processes, both multilayer and extrusion coating.

Higher line speeds for up to double the throughput

The greater film stability of Akulon®XP allows higher line speeds, so up to double the throughput can be achieved on existing lines compared with standard PA6 grades. That means not only lower costs per unit, but also the ability to meet growth plans by increasing production on existing lines, allowing further capital investments to be postponed. Or where higher throughput is not required, power consumption can be significantly reduced at existing line speeds.

Outstanding rheology and bubble stability optimize end-product quality

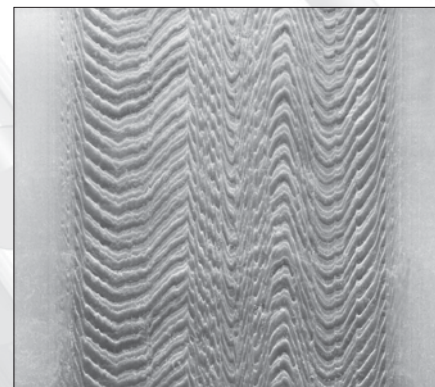
The rheology of Akulon®XP optimizes end-product quality while at the same time saving cost. For example the more even thickness distribution allows the use of thinner tie and barrier layers, while ensuring that the specified barrier performance is maintained. The inherently high bubble stability of Akulon®XP even allows multilayer constructions without an LDPE layer to be produced reliably in blown film processes.



Akulon XP offers a near-perfect viscosity match for LDPE over the entire range of shear rates, resulting in excellent rheological matching.

Broader processing window reduces dependence on die design

Consistency and quality are enhanced across a wide range of process conditions by the broader processing window of Akulon®XP on any multilayer line. This also reduces dependence of layer distribution on die design, avoiding the need for frequent hardware changes, increasing process flexibility and allowing easy line switching to different multilayer constructions.



Akulon®XP eliminates 'wave' effects (eg. above) is caused by rheology mismatches.

Reduced neck-in for greater effective width

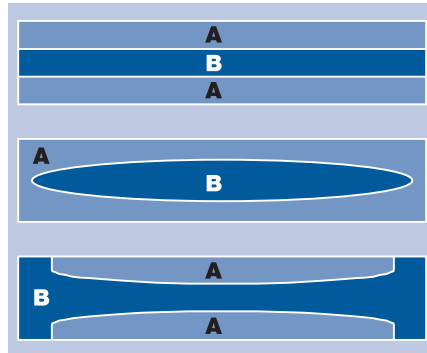
Further increasing productivity and minimizing waste, Akulon®XP's reduced neck-in means that up to 95% of the machine width can be used. The resulting constant quality and even layer thickness across the full width of the film maximizes process yield and eliminates the need for wide edge trimming.

New value opportunities in extrusion coating

The unique properties of Akulon®XP open up new opportunities to create added value in extrusion-coating processes. For example in applications where polyamide layers are necessary to achieve the required barrier properties, but the use of conventional materials results in stability and processability problems.

Just a few examples of how Akulon®XP saves cost and adds value in specific extrusion-coating applications are:

- dried food packaging, using puncture-resistant Akulon®XP layers on paper
- an Akulon®XP layer as an oxygen and aroma barrier for drinks cartons, replacing a more expensive aluminium layer
- using Akulon®XP as a high-temperature dust- and waterproof sealant coating on non-woven fabrics.



Optimum rheological matching of Akulon XP with PE ensures a perfect gauge distribution and resulting greatly reduced neck-in (top). Common mismatches are caused by too-high (center) or too-low (lower) viscosity of material B relative to material A.

Akulon® XP: the 'Xtreme Performance' polyamide

Matched rheological characteristics are vital to minimize neck-in and ensure even layer distribution in multilayer film constructions. Akulon®XP excels with similar rheological behaviour and film stability to PE. Its viscosity curve is a better match for PE than that of standard PA6 over a wide range of shear rates, resulting in a broad processing window in co-extrusion. By eliminating rheology and viscosity mismatches, Akulon®XP makes it much easier to achieve a perfect, consistent gauge distribution. That translates directly into reduced neck-in, for a wider usable film width, constant quality right up to the edges and less product wastage.

Cost-optimized tie layers

Yparex® PE-based extrudable adhesive resins act as high-performance tie layers in multilayer barrier films for food packaging applications requiring low oxygen permeability. These resins consist of polyolefins with incorporated functional groups to achieve the high bonding levels between PE and PA or EVOH which are required to prevent material delamination. They ensure optimal adhesion and processing characteristics in multilayer extrusion of dissimilar film materials, while not affecting the good optical properties of the other film layers.

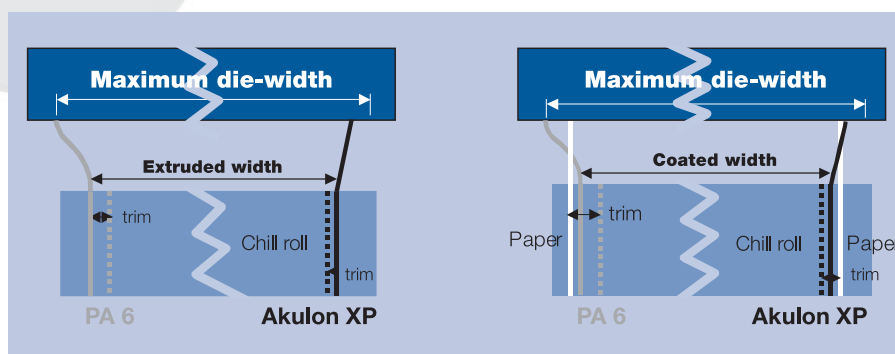
Optimizing adhesion and processing performance

Yparex® resins are available for the full range of conversion processes. Different grades offer a choice of rheological, optical and heat stability properties, allowing adhesion and processing performance to be optimized for specific applications.

Cost optimization by a choice of grades

Costs can be optimized by choosing Yparex® grades with different levels of activity as tie layers for co-extrusion processes. DSM can provide application support based on in-depth technical knowledge of film extrusion processes, even up to the development of special tie layer recipes or new Yparex® grades.

Neck-in on cast film and coating processes.



How to create value with monolayer film

Other specialty film products from DSM can add value to a wide range of applications, both as packaging films and in other areas.

Akulon® PA6 cast monolayer film for laminated packaging

Akulon® PA6 cast film provides an oxygen barrier packaging film with an excellent price-performance ratio for fresh food products such as meat and cheese. It offers high consistency with very low gel counts and good melt stability.

Akulon® PA6 and PA66 blown film for high-strength packaging

With its exceptional viscosity and melt stability – especially in the case of Akulon® PA66 – these blown films can be used wherever packaging is subject to high mechanical and thermal loads, for example in roasting bags and skins for processing large sausages.

Arnitel® Modified Atmosphere Packaging

Thanks to its perm selectivity, Arnitel® is an ideal material for packaging of fresh foods such as vegetables. It combines high CO₂ permeability with low oxygen permeability, providing a controlled atmosphere to avoid anaerobic processes so food remains fresher for longer and shelf life is extended.

Arnitel® in meat packaging

For meat packaging Arnitel® provides a tough, puncture-resistant monolithic health barrier with excellent film characteristics. It can be used at every stage of the food chain, from transport right through to cooking at up to 160°C and subsequent distribution, protecting food from bacteria and other forms of contamination. Manual handling is greatly reduced by eliminating repeated packing and unpacking, improving food hygiene and minimizing losses.

Stanyl® in high-temperature packaging

Stanyl® is a tough protective film with short-term heat-resistance up to 275°C. It offers oxygen barrier properties 50% better than those of BOPA, with a reasonable moisture transmission level. Stanyl® films are capable of being produced with thicknesses down to 15 µm.

Other innovative film applications

Arnitel®

- Breathable film for roofing: Arnitel® keeps out rain and wind while letting moisture out, thereby preventing rot from developing in roofing timbers
- Medical films: a monolithic Arnitel® layer provides protection against bacteria and viruses which can pass through conventional microporous films, but also provides comfort as moisture is transpired
- Clothing: an Arnitel® layer makes garments wind- and water-resistant. Comfort is optimized by maintaining flexibility at low temperatures and offering permeability to perspiration
- Thermoset curing bags made of Arnitel® are heat-resistant and enable easy release at the end of the processing time
- Decorative films for in-mold decoration: Arnitel® layers are thermoformable, with good adhesion to PC and blend substrates, and are also easily printed.

Akulon® PA6

- Agricultural film: Akulon® PA6 in co-extrusion with LDPE is a tough, puncture-resistant film with oxygen barrier properties that make it ideal for environment-friendly soil fumigation without the use of pesticides
- Foam coverings: extrusion-coated Akulon® PA6 protective layers are resistant to heat as well as to automotive fuels and oils.

Working together to optimize your applications

As a leading global supplier of engineering plastics, backed by extensive materials and application knowledge, DSM is your perfect partner to unlock hidden value in your products and processes.

For producers of packaging and barrier films, we are committed to maximizing your line productivity and end-product quality:

- By a constant program of customer-focused R&D and application development
- By offering one of the world's widest ranges of state-of-the-art products and grades
- By providing our customers with knowledgeable, proactive application support
- By ensuring excellent customer service and logistics through every stage of the supply chain
- By acting as a co-maker, with a dedication to solving technical challenges in customers' processes and applications.

Europe

The Netherlands

DSM Engineering Plastics
Poststraat 1
P.O. Box 43
6130 AA Sittard
Tel. +31 46 47 73381
Fax +31 46 47 70101

USA

North America

DSM Engineering Plastics
P.O. Box 3333
2267 West Mill Road
Evansville, IN 47732-3333
Tel. +1 812 435 7500
Fax +1 812 435 7702

Asia Pacific

DSM Engineering Plastics
Suite A, 10th Floor
Century BA-Shi Building
No. 25 Mid Chongqing Road
Shanghai 200020, China
Tel. +86 21 6386 3080
Fax +86 21 6386 2198

DSM Engineering Plastics
www.dsmep.com - www.akulon.com