



NUREL Engineering Polymers

Polymerization & Polymer Additivition

NUREL's long term experience in polymerization processes and polymer modification have converged to provide a portfolio of polyamide extrusion grades with a wide viscosity range and different additive packages.

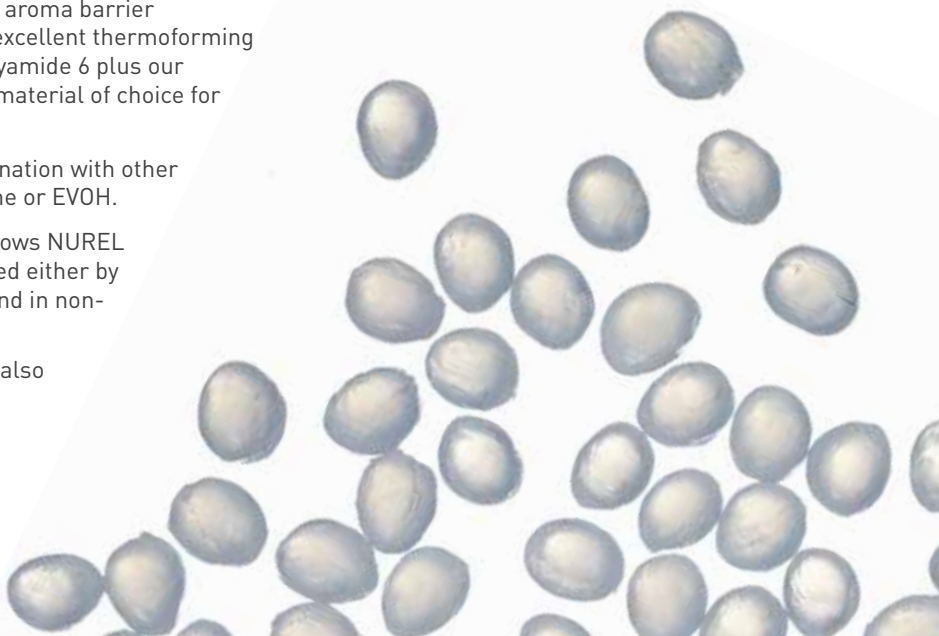
Promyde® Polyamide 6

Promyde provides excellent gas, flavour and aroma barrier properties, as well as high mechanical and excellent thermoforming functionalities. These inner attributes of polyamide 6 plus our quality and consistency, make Promyde the material of choice for film or laminate production.

Promyde can be extruded alone, or in combination with other polymers such as polyethylene, polypropylene or EVOH.

Our technology applied to product design allows NUREL to offer specific grades that may be processed either by cast or blown, in monolayer or coextruded and in non-oriented or oriented film.

NUREL's product portfolio includes PA6 and also copolyamides for special applications.



Technical Polyamides in Your Daily Life

Packaging plays an important role in extending the durability of goods. In some applications like barrier, vacuum and MAP films, Promyde® provides fundamental benefits

Promyde's oxygen and gas barrier avoids ageing and discolouration, whilst preserving odours and flavours.

It delivers high mechanical strength, puncture resistance, heat resistance even at sterilizing temperatures, and thermoformability. When using BOPA films, some properties are enhanced, such as puncture resistance, strength and stiffness, and also elongation at break.

Polyamide is used as a component of coextruded or laminated multilayer film to protect foodstuffs from oxidation. For example: for meat, sausage casings, cheese, coffee, stand-up pouches for sauces, shrink bags, etc.

Promyde is also used in medical film to safely protect medical devices, in decorative and protecting film, and in agriculture i.e. mulching films to increase the effect of herbicides and lessen their environmental impact.



Packaging and Film Applications



Promyde high performance polyamides - delivering solutions that can satisfy the most challenging requirements

CAST EXTRUSION



BLOWN EXTRUSION



BOPA



TRIPPLE BUBBLE



Technikum: Our Focus is your Success

NUREL's technical and R&D facilities, as well as our expertise and know-how, are part of our Customer Service.

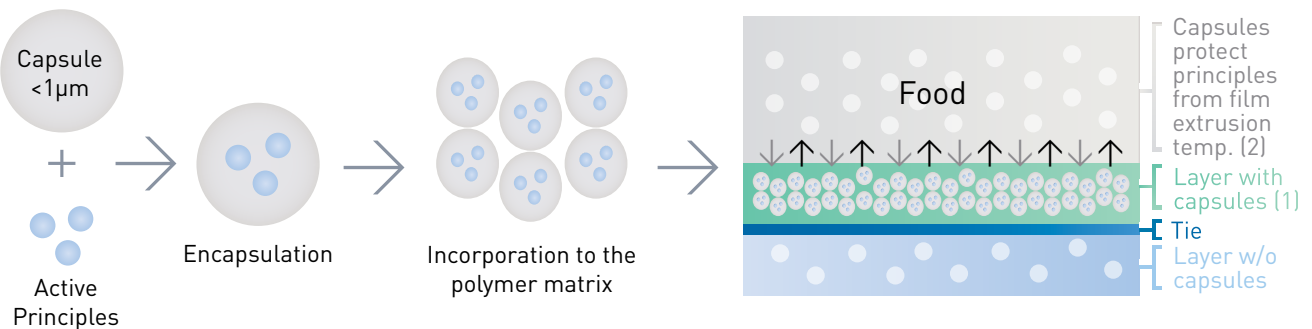
- POLYMERIZATION FACILITIES, including lab-scale and pilot-scale reactors and a polycondensation unit
- CAST AND BLOWN MONOLAYER PILOT LINES:
 - Extruder Ø 25mm, length 25D
 - Max. throughput 5 Kg/h
 - Max. temperature 300°C
 - Film thickness range: 20-500 microns
- A COMPLETE CHARACTERIZATION LABORATORY:
 - Optical properties
 - Tensile properties
 - Puncture resistance
 - Trouser tear resistance
 - Sealing properties
 - Dynamic and static coefficient of friction, Plastic/Plastic and Plastic/Metal
 - Oxygen transmission rate
 - Moisture vapour transmission rate

Technikum is our answer to any new project, technical enquiry or service, or any other question related to polymers

Active Packaging

This innovation extends the self life of packed food. Our Active Packaging technology consist of incorporating encapsulated active principles to the polymer matrix in order to provide antioxidant, antimicrobial or antifungal properties. Our capsules can also help to remove, from packed food, undesired substances such us liquids, odours and gases.

MICROENCAPSULATION TECHNOLOGY



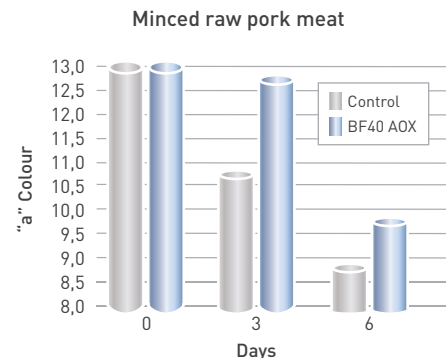
- (1) Active principles are released outside the capsules by air controlled diffusion method (pressure difference inside/outside the capsule). Higher diffusion towards the food side layer occurs due to the food contact and moisture.
- (2) Gas-phase radicals permeate trough layer with capsules being stabilized.

ANTIOXIDANT

Based on encapsulated natural antioxidant extract. It is active at vapour phase, vapour radicals from oxidation are neutralized by the active principles.

Test in-vivo Visual colour (CIELAB Colour Space Model)

- Food: raw chicken breast, pork steaks and pork ground patties
- Shelf life: 4 days
- Packaging: Vacuum, 50 microns films (control and antioxidant)
- Storage: 7°C during 6 days
- Quality controls: "a" Colour (red colour)



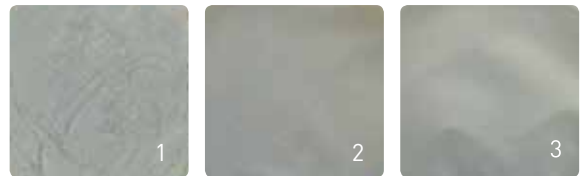
ANTIMICROBIAL

Based on natural essential oils. It is active at vapour phase as encapsulated antimicrobial actives are volatile compounds. Direct contact with food is not required.

Test in-vitro without contact (activity in vapour phase)

- Total inhibition of the growth of Salmonella Enterica

1. Control (LDPE & PP films without capsules)
2. LDPE film with capsules: Total inhibition
3. PP film with capsules: Total inhibition



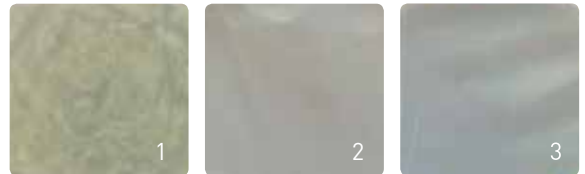
ANTIFUNGAL

Based on natural essential oils. It is active at vapour phase as encapsulated antifungal actives are volatile compounds. Direct contact with food is not required.

Test in-vitro without contact (activity in vapour phase)

- Total inhibition of the growth of Aspergillus Flavus

1. Control (LDPE & PP films without capsules)
2. LDPE film with capsules: Total inhibition
3. PP film with capsules: Total inhibition



Promyde® Copolyamide

Our offer for the most demanding requirements

Promyde® copolyamide products are recommended for manufacturing films with high transparency, flexibility, good thermoformability and high shrink properties. Furthermore they are specially suitable for non-symmetrical structures to reduce curling.

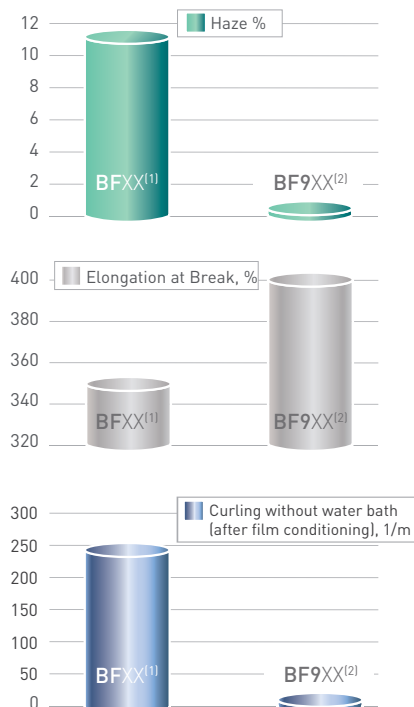
Promyde BF9XX⁽²⁾ L and Promyde BF9XX⁽²⁾ LN are high viscosity polyamides formulated to have a lower crystallization temperature.

They can be processed in cast and blown film extruders. A lower temperature profile can be used when using standard Promyde grades. Please refer to page 9 for processing temperature table.

Key Properties

Compared to standard polyamide, Promyde copolyamide product range offers:

- A lower melting temperature, which is the key for coextrusion of polymers that are temperature sensitive, e.g., EVOH.
- A lower crystallization temperature that allows the production of more transparent and flexible films.
- A higher pin-hole resistance, specially requested for packing products with sharp ends.
- A higher tear strength.
- A higher elongation to break and deep drawing, that permits the production of thermoformable films.



⁽¹⁾ All our BFXX products.

⁽²⁾ All our BF9XX products.



Promyde® Polyamide is processed either by CAST or BLOWN extrusion for industrial manufacture of monolayer and multilayer film, including both non-oriented and biaxially oriented (BOPA) film.

The film extrusion industry demands the highest quality polyamide. Promyde delivers the continuous reliability it requires.

Screw Recommendations

- Standard single-flighther, three-section screws.
- Better results can be obtained by using high performance screws equipped with shearing and mixing sections.
- The screw length should be at least 24D, and preferably 28-33D to guarantee optimum plasticizing and conveying with the high through-put rates of film extrusion (D: screw diameter).
- A three-section screw should have a compression ratio (ratio of flight depth in the feed section to flight depth in the metering section) of 3:1 to 4:1.
- Screw length sections (L: overall length of screw):
 - Feed section: 0.25 to 0.30 x L
 - Compression section: 0.15 to 0.25 x L
 - Metering section: 0.40 to 0.55 x L

Processing Temperatures

Property	Cast Extrusion		Blown Extrusion	
	PROMYDE BFXX ⁽¹⁾	PROMYDE BF9XX ⁽²⁾	PROMYDE BFXX ⁽¹⁾	PROMYDE BF9XX ⁽²⁾
Feed section	210-240 °C	210-225 °C	210-240 °C	210-235 °C
Compression section	240-260 °C	225-235 °C	235-245 °C	235-245 °C
Metering section	250-265 °C	235-240 °C	245-250 °C	245-250 °C
Die	250-265 °C	235-240 °C	235-240 °C	235-240 °C
Melting temperature	255-265 °C	235-240 °C	245-250 °C	245-250 °C

⁽¹⁾ All our BFXX products.

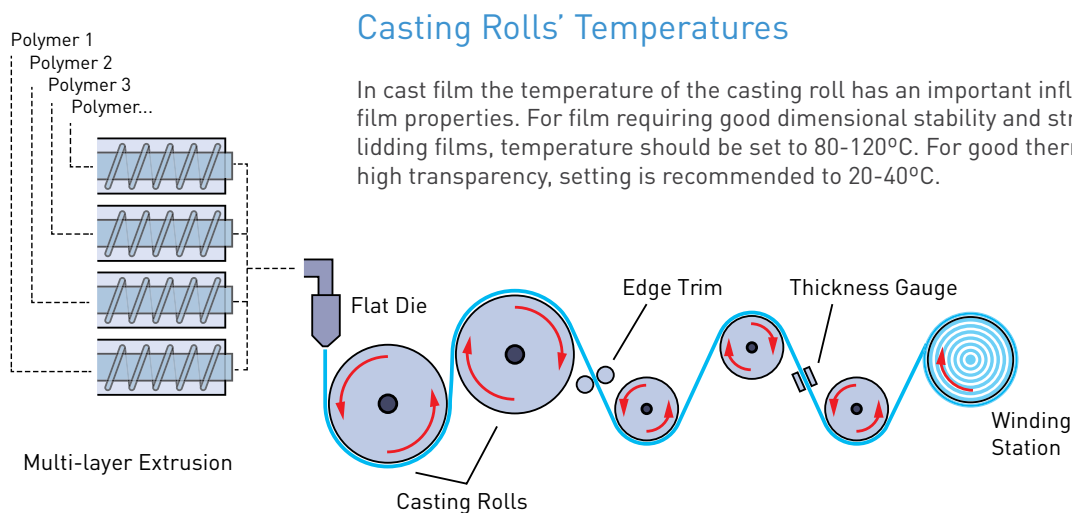
⁽²⁾ All our BF9XX products.

Promyde® CAST Extrusion

CAST Extrusion

Cast film extrusion is a continuous operation of melting one or more polymers through a flat die to form a film that will be conveyed to successive rollers with different functions (cooling, film finishing, etc.), and finally wound onto a roll.

Typical film thickness ranges are between 20-200 μm and width of 400-3,000 mm. Film thickness is controlled with the die gap and the extrusion line speed.



Casting Rolls' Temperatures

In cast film the temperature of the casting roll has an important influence on the film properties. For film requiring good dimensional stability and strength, such as lidding films, temperature should be set to 80-120°C. For good thermoforming and high transparency, setting is recommended to 20-40°C.



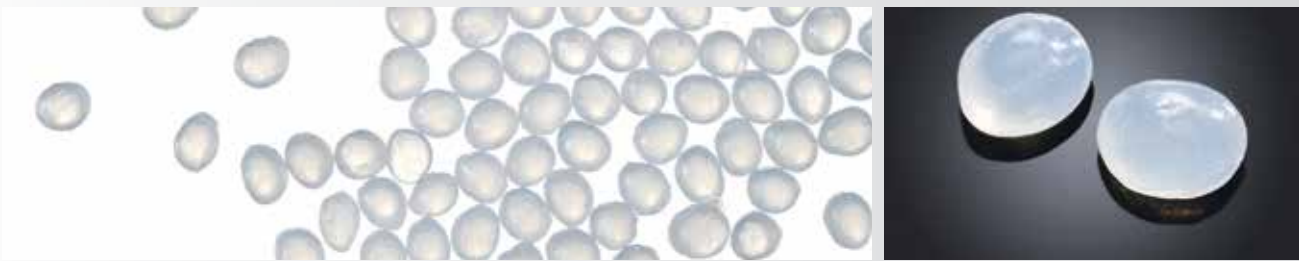
Promyde® product range properties on CAST Film

Property	Unit	Method	PROMYDE BFXX ⁽¹⁾		PROMYDE BF9XX ⁽²⁾	
			Chill roll: 50°C	Chill roll: 90°C	Chill roll: 50°C	Chill roll: 90°C
Yield stress (MD / TD)	MPa	ISO 527-3	25-35	25-35	20-30	20-30
Stress at break (MD / TD)	MPa	ISO 527-3	70-80	70-80	60-70	60-70
Strain at break (MD / TD)	%	ISO 527-3	370-380	340-350	390-410	390-410
Trouser tear force (MD)	N	ISO 6383-1	0.6-0.9	0.5-0.6	2.0-3.0	2.0-3.0
Trouser tear resistance (MD)	N/mm	ISO 6383-1	15-20	10-15	40-50	40-50
Puncture force (MD)	N	ISO 14477	4.5-5.0	4.5-5.0	5.0-6.0	5.0-6.0
Puncture elongation (MD)	mm	ISO 14477	3.5-4.0	3.5-4.0	4.0-6.0	4.0-6.0
Puncture resistance (MD)	mJ	ISO 14477	9-10	9-10	12-15	12-15
Haze	%	ASTM D1003 (Procedure B)	<0.5	5-6	<0.5	<0.5
Static coefficient of friction (Film/Steel)		ISO 8295	<0.5	<0.35	<0.35	<0.35
Dynamic coefficient of friction (Film/Steel)		ISO 8295	<0.25	<0.25	<0.25	<0.25

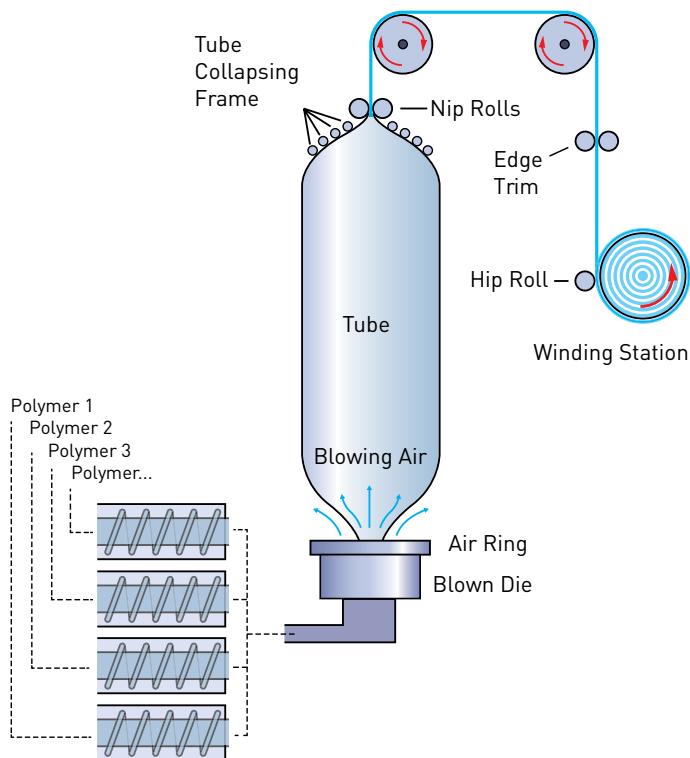
⁽¹⁾ All our BFXX products.

⁽²⁾ All our BF9XX products.

Extrusion Process	Products
CAST	BF33 L, BF33 LN, BF36 L, BF36 LN, BF36 SLN, BF38 L, BF38 LN, BF40 L, BF40 LN, BF933 L, BF933 LN, BF940 L, BF940 LN



Promyde® BLOWN Extrusion



BLOWN Extrusion

Blown film extrusion is a continuous operation of melting one or more polymers through a circular die to form a hollow tube. The tube is expanded with air, collapsed and finally rolled up.

Processing Recommendations

- Blown-up ratio: 1.1-3.0
- In asymmetric structures, curling may be reduced by wetting the film in a warm water bath.
- Cooling:

Air cooling: copolyamides are mainly used to achieve better optical properties and low curling in non-symmetric structures, like PE/Tie/PA. For stiffer films, copolyamides can be combined with Promyde® PA6.

Water cooling: for better optical properties and thermoformability. Copolyamides and Promyde PA6 can be used.



Promyde® product range properties on BLOWN Film

Property	Unit	Method	Blown film (50 m, BUR:3)	
			PROMYDE BFXX ⁽¹⁾	PROMYDE BF9XX ⁽²⁾
Yield stress (MD / TD)	MPa	ISO 527-3	25-35	20-30
Stress at break (MD / TD)	MPa	ISO 527-3	70-80	60-70
Strain at break (MD / TD)	%	ISO 527-3	340-370	390-410
Trouser tear force (MD)	N	ISO 6383-1	0.8-1.2	2.0-3.0
Trouser tear resistance (MD)	N/mm	ISO 6383-1	16-22	40-50
Puncture force (MD)	N	ISO 14477	5-6	5-6
Puncture elongation (MD)	mm	ISO 14477	2.5-3.5	3.0-5.0
Puncture resistance (MD)	mJ	ISO 14477	8-10	9-12
Haze	%	ASTM D1003 (Procedure B)	10-12	<0.5
Static coefficient of friction (Film/Steel)		ISO 8295	<0.35	<0.35
Dynamic coefficient of friction (Film/Steel)		ISO 8295	<0.25	<0.25
Oxygen transmission rate, 23°C, 0% RH	cc/m ² .d.atm	ASTM D3985	25	25
Oxygen transmission rate, 23°C, 50% RH	cc/m ² .d.atm	ASTM D3985	15	15
Oxygen transmission rate, 23°C, 85% RH	cc/m ² .d.atm	ASTM D3985	40	30
Moisture vapour transmission rate, 23°C, 85% RH	g/m ² .d	ISO 15106-1'	25	20
Moisture vapour transmission rate, 38°C, 85% RH	g/m ² .d	ISO 15106-1'	75	65

⁽¹⁾ All our BFXX products.

⁽²⁾ All our BF9XX products.

Extrusion Process	Products
BLOWN	BF38 L, BF38 LN, BF38 SL, BF933 L, BF933 LN, BF940 L, BF940 LN



Promyde® BOPA Extrusion

BOPA Extrusion

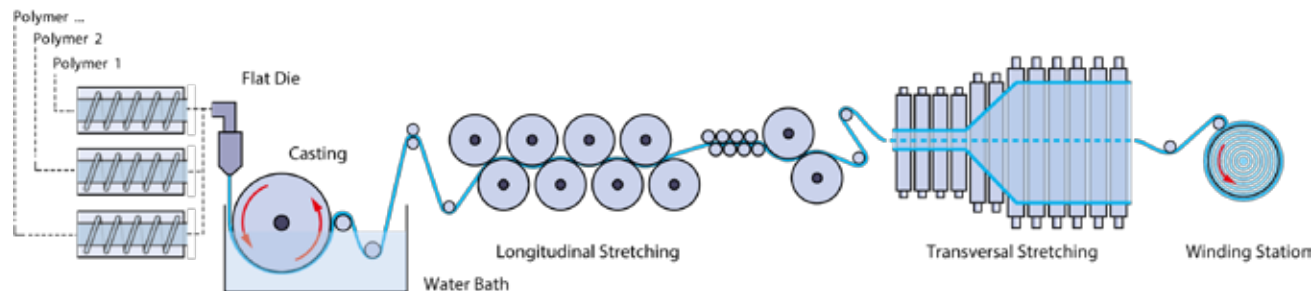
Biaxially Oriented Polyamide films are special structures with high gas barrier and excellent mechanical properties (tear and puncture resistance), also achieving thinner thicknesses. It is specially recommended for frozen packaging, top fill for rigid trays or vacuum packaging applications.

Extrusion Process	Products
BOPA	BF33, BF33L

Processing Recommendations

For simultaneous BOPA lines where MD and TD stretching is performed in one step, the use of lubricant is not required, for this applications we recommend the use of Promyde® BF33 or BF33L. A temperature of 45-60°C is recommended during MD stretching and 75-100°C during TD stretching.

BOPA sequential lines first stretch the film in MD and then on a second step stretch the film in a transversal direction. In this case during MD stretching hydrogen bonds are generated between PA chains, for this reason we recommend the use of lubricated products to assist the TD stretching (Promyde BF33L).



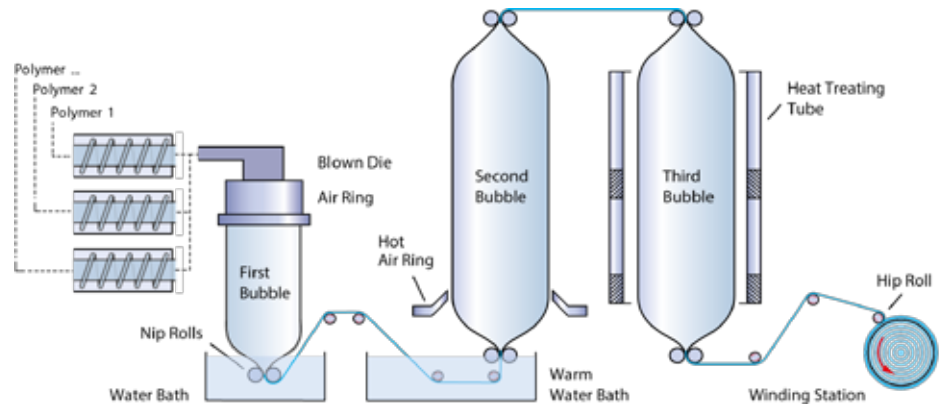
TRIPLE BUBBLE Extrusion

The main purpose of using Triple-bubble technology is to get a good controlled shrinkage and improve mechanical properties of down gauging films. The use of polyamide is mainly recommended for sausage casings and coextruded for high barrier packaging shrink film.

Extrusion Process	Products
TRIPLE BUBBLE	BF38, BF38L, BF38 SL, BF40, BF40L

Processing Recommendations

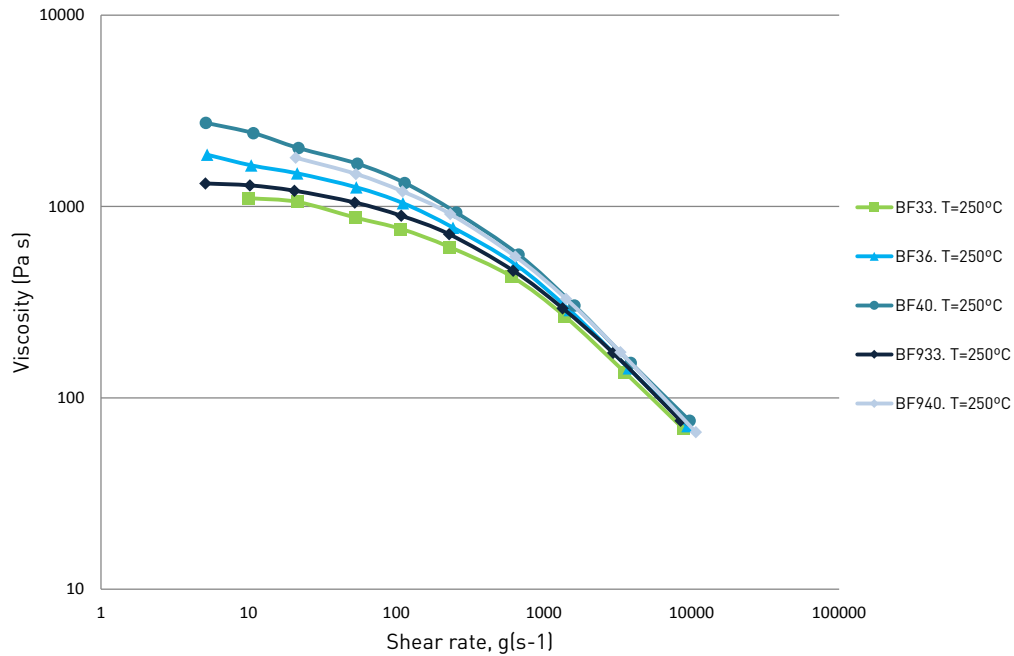
First bubble is collapsed and cooled down quickly in order to minimize the crystallization, then the film is warmed up in a hot water bath and then blown and oriented in a second bubble, in this orientation step MD: 2.0-3.3 and TD: 2.5-3.8 ratios are recommended. After the second bubble collapsed the annealing step takes place by a third bubble which is maintained at a certain temperature in order to control the % of shrinkage of the final product.



Viscosity vs Shear Rate

Viscosity vs Shear Rate

*Moisture: 200-300 ppm



Nomenclature

- BF: film extrusion grade
- Number: refers to Relative Viscosity measured in 96% sulphuric acid, 1% polymer in solution, 25°C (ISO 1628)
- L: Lubricated ⁽¹⁾
- N: Nucleated
- LN: Lubricated and Nucleated
- SL: Special lubrication for higher bright and lower friction

For other grades please contact your NUREL representative.

⁽¹⁾ All lubricated products are also available with non animal derived additives (VL).

Promyde® product range

Product	Viscosity Number ISO 307 (ml/g)	Additive Package
BF33	193 - 211	-
BF33 L	193 - 211	Lubricant
BF33 LN	193 - 211	Lubricant & Nucleant
BF36 L	220 - 237	Lubricant
BF36 LN	220 - 237	Lubricant & Nucleant
BF38	237 - 254	-
BF38 L	237 - 254	Lubricant
BF38 LN	237 - 254	Lubricant & Nucleant
BF40 L	254 - 272	Lubricant
BF40 LN	254 - 272	Lubricant & Nucleant
BF933	193 - 211	-
BF933 L	193 - 211	Lubricant
BF933 LN	193 - 211	Lubricant & Nucleant
BF940	254 - 272	-
BF940 L	254 - 272	Lubricant
BF940 LN	254 - 272	Lubricant & Nucleant

Extrusion Process	Products
CAST	BF33 L, BF33 LN, BF36 L, BF36 LN, BF36 SLN, BF38 L, BF38 LN, BF40 L, BF40 LN, BF940 L, BF940 LN
BLOWN	BF38 L, BF38 LN, BF38 SL, BF933 L, BF933 LN, BF940 L, BF940 LN
BOPA	BF33, BF33L
TRIPLE BUBBLE	BF38, BF38L, BF38 SL, BF40, BF40L



Conditioning

Before converting, cutting or laminating a PA film, it should be conditioned.

Polyamide is a hygroscopic polymer that absorbs humidity after being processed. A polyamide film reaches its equilibrium by storing it in a controlled moisture and temperature environment. Active conditioning techniques such as in-line humidification or water quenching can also be used.

When conditioned, film will improve its elastic and thermoformability properties, and achieve its final dimensions and properties.

Printing and metallizing

PA films can be also printed or metallized without any special treatment. For better results corona treatment is recommended.

Handling and Storage

Material is supplied pre-dried and ready to process. Bags and containers should be stored in a dry place at room temperature not exceeding twelve months. Material from open or damaged containers should be dried at 75 to 80°C.

Food Legislation

Promyde® fully complies with EU and FDA regulations related to plastic materials intended to come into contact with foodstuffs.

EU Regulations: Regulation (EC) 1935/2004 and Commission Regulation (EU) 10/2011.

FDA Regulations: Compliance with all specifications and limitations stated in USA FDA 21 CFR (B) §177.1500, (a) 6 and (b) 6.1 and 6.2 "Nylon Resins".

For further information, please, contact your NUREL representative.





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