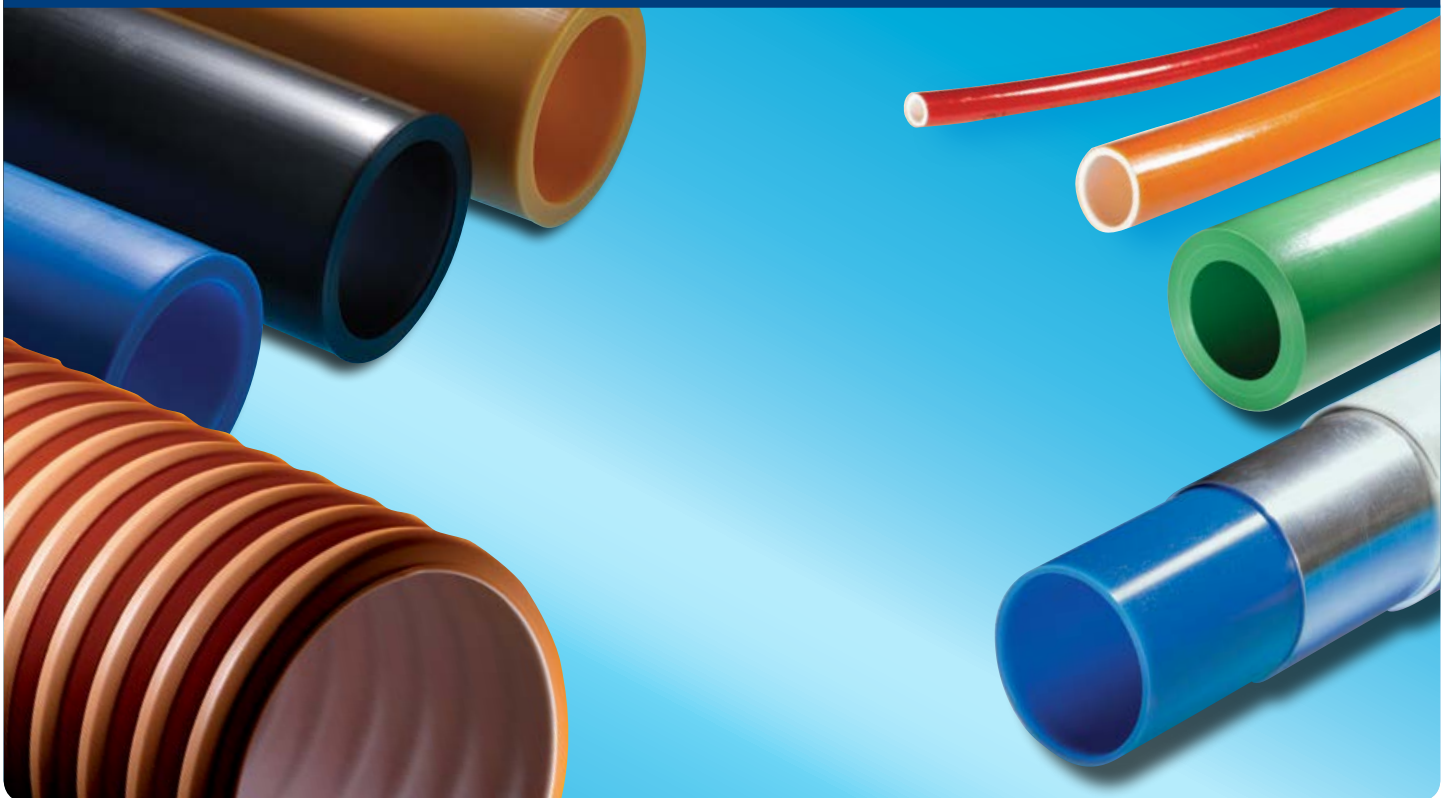


Value-based polyolefin solutions used in pipe applications



About LyondellBasell

LyondellBasell is the world's third-largest independent chemical company. Our vertically integrated facilities, broad product portfolio, manufacturing flexibility, superior technology base and reputation for operational excellence enable us to deliver exceptional value to our customers across the petrochemical chain – from refining to advanced product applications.

We manufacture products and develop technologies that improve the quality of life for people around the world. Our products are the basic building blocks used to manufacture countless everyday goods such as personal care products, fresh food packaging, lightweight plastics, high-strength construction materials, automotive components, biofuels, durable textiles, medical applications and many others. With the help of LyondellBasell materials, thousands of products are made safer, stronger, more affordable and more reliable.

Adding value for customers

Customers in the pipe industry, including steel pipe coating companies, are served by a dedicated team of LyondellBasell experts which offers benefits that deliver a competitive advantage:

- Strong market reputation
- 50 years of experience
- Quality products, services and people
- Leadership in technology and innovation
- Global Pipe & Infrastructure business unit, with sales and technical service teams in Europe, North America and Asia-Pacific



Sustainable water management

Water scarcity concerns are on the rise in a number of regions. With our broad portfolio of polyolefins used in piping systems, LyondellBasell can contribute to making nature's water cycle more efficient. Piping systems made from polyolefins can provide sustainable and reliable water management solutions for generations to come.

Water shortages arise when there is a mismatch between where rain falls and where populations dwell. For example, India and China combined comprise 35 percent of the world's population, but only nine percent of the earth's water supply. During the past 50 years, growing populations, expanding cities and changing lifestyles have increased water consumption by 200 percent. Only 20 percent of the water consumed globally comes from groundwater, which can no longer be regarded as an unlimited source. Sustainable water management within the entire water circle is more important than ever.

Benefits of LyondellBasell resins

The water circle in Fig. 1 illustrates how water moves from natural sources to water treatment, distribution, consumption, disposal, wastewater treatment, and

then back to nature. Within the water distribution, consumption and disposal sections, piping systems produced using polyolefins contribute to making the water circle more efficient.

Water distribution systems use high-pressure pipes made from steel, which are protected from corrosion with top-coat materials such as LyondellBasell's *Lupolen 4552 D black*. Medium-pressure HDPE pipes produced using the company's *Hostalen CRP 100* product family have an expected service life of 50 years. These fully welded, tight-fitting piping systems are designed to prevent infiltration or exfiltration. Leakage rates are considerably lower than pipes produced with traditional materials such as steel or ductile iron. Pipes made from HDPE help transport water to households more efficiently than those produced with competitive materials.

Sanitary piping systems made from PE-X, PE-RT, PP-R and PB-1 ensure safe hot and cold water distribution inside homes and commercial buildings. Plastic pipes also provide better sound dampening performance than those produced using copper, offering improved comfort.

In the disposal of waste water, *Hostalen* PP resins are the materials of choice for today's sanitation systems. Push-fit jointing systems enable fast and economical installation. Pipes made from PP materials are light, and can be handled safely and easily during installation at the trench. Polypropylene-based pipes transport water back to wastewater treatment plants, preventing infiltration and exfiltration.

All of the polyolefin solutions described above exhibit extensive durability, reliability and sustainability, with an expected service life of up to 50 years.



Fig. 1 – Water circle – courtesy of Hewing (PE-X), REHAU (PP-B)

Polyolefin systems used in steel pipe coating

LyondellBasell offers a wide range of PE and PP products used in anti-corrosion coating, mechanical protection and thermal insulation coating applications for oil, gas and water transportation pipelines.

In three-layer steel pipe coating, customers apply the *Lupolen* 4552 D black PE top-coat, and the *Lucalen* G3710 E PE adhesive to achieve outstanding protection from impact, ageing and corrosion, even at high operating temperatures of up to 85°C.

Lupolen 4552 D black is a multimodal, black HDPE product used by customers due to its outstanding resistance to environmental stress cracking (ESCR), superior impact resistance and excellent processability, even at high coating speeds.

Lucalen G3710E PE – available in pellet and powder form – is a new grafted adhesive resin that customers use due to its superior adhesion, improved processability and wide application window compared to standard grades.

Our PP-based coating products are widely used in pipelines that transport hot liquids, with elevated operating temperatures from 85°C up to 140°C. *Moplen* Coat EP/60 BIANCO is a well-established, white top-coat resin with excellent thermal ageing resistance and UV-protection, typically applied by customers with the grafted adhesive resins *Hifax* EPR/60 BIANCO or *Hifax* EP2 015/60 on pipelines with very high service temperatures.

LyondellBasell also offers *Hifax* products used in flame spray coatings and thermal insulation coatings for off-shore, deepwater pipeline projects.



Fig. 2 – Steel pipes with HDPE top-coat – courtesy of Socotherm España



Fig. 3 – Steel pipe with PP top-coat

HDPE used in pressure pipe applications

LyondellBasell's experience and reputation for technology and innovation in the development and production of grades used in the pipe sector spans more than 50 years. Since the production of the first *Hostalen* HDPE pipe grades in 1955, the range of products has been expanded and upgraded to encompass a complete portfolio of polyolefin grades used by customers in pipe systems.

Hostalen HDPE used in pressure pipes for drinking water, gas, sewage and industrial applications

LyondellBasell's HDPE resins used by customers in pipe systems combine high impact strength and stiffness at ambient and low temperatures, enabling the production of pressure and non-pressure applications.

The *Hostalen CRP 100* black, *Hostalen CRP 100* blue and *Hostalen CRP 100* orange grades are increasingly acknowledged as quality leaders in the current PE 100 generation.

Compared to standard grades, *Hostalen CRP 100 RESIST CR* black and *Hostalen CRP 100 RESIST CR W* blue demonstrate higher resistance to stress cracking under demanding installation conditions.

Hostalen CRP 100 XL black is selected by customers for the production of large bore pipes with thick pipe walls.

Hostalen CRP 100 RD – the latest grade in the range offers superior properties towards new disinfectant systems.

Hostalen GM 5010 T3 black is a PE 80 grade that exhibits a very good balance of properties.

Hostalen HDPE grades are produced using a low-pressure slurry process plant, based on LyondellBasell's latest-generation *Hostalen* Advanced Cascade Process (ACP) technology.

Alathon HDPE grades (natural) used in pressure pipes

Alathon HDPE grades are bimodal, high molecular weight copolymer

resins designed to address the high-performance requirements of pressure pipe applications.

Alathon L4904 can be considered for applications that require resistance to rapid crack propagation. Compared to standard grades, this material exhibits improved melt strength and resistance to stress cracking. The resin is a performance leader in the latest PE 4710 class.

Alathon L5008HP and *Alathon L5008* grades are well-established pipe resins which fulfil the requirements of the current PE 4710 and PE 4608 generations respectively. *Alathon* HDPE grades are only available in North and South America.

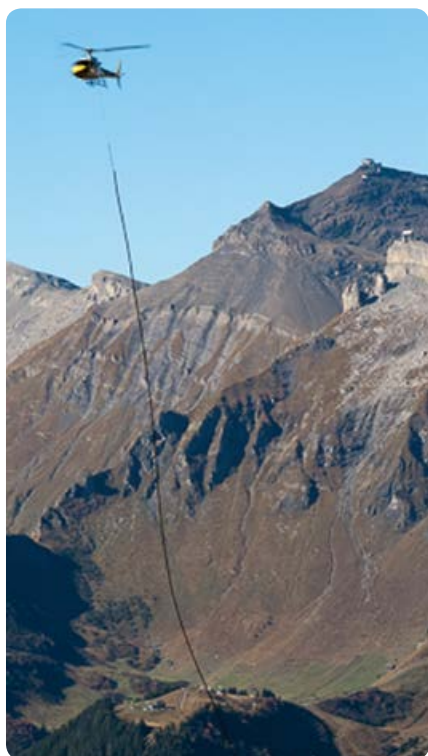


Fig. 4 – Pipe transport by helicopter



Fig. 5 – Seaoutfall line – courtesy of PLOMYPLAS



Fig. 6 – Extrusion of an 800 mm pipe

Heating and plumbing applications

Over the past four decades, polyolefin products have been steadily replacing traditional materials such as copper in hot water pipe applications. This change began more than 35 years ago, with the development of high molecular weight HDPE for cross-linked pipes. Today, LyondellBasell offers a wide range of PE-X, PE-RT, PP-R and PB-1 products used in heating and plumbing applications.

LyondellBasell offers a range of *Lupolen* grades used in all common cross-linking techniques

- *Lupolen* 5261 Z Q 456 for PE-Xa
- *Lupolen* 5261 Z Q 456 B for PE-Xa
- *Lupolen* 5461 B Q 471 for PE-Xa
- *Lupolen* 5031 L Q 449 K for PE-Xb
- *Alathon* M5370 PX for PE-Xb
- *Lupolen* 4261 A Q 416 for PE-Xc
- *Lupolen* 4961 D for PE-Xa

Cross-linking takes place during or after production, leading to extremely high crack resistance and extending the operational temperature up to 95°C.

Cross-linked pipes are typically used in household plumbing applications; industrial and domestic surface heating and cooling; radiator connections; district heating; and anti-freeze systems.

PE-X is also used in special large-diameter applications – up to 630 mm – for the transport of chemical substances and industrial slurries at elevated temperatures. LyondellBasell customers report that PE-Xa pipes have abrasion resistance five times that of HDPE pipe used in mining applications.

A new PE-RT Type II material

Hostalen 4731 B is a PE-RT resin that meets the PE-RT Type II classification and is used in underfloor heating pipes and aluminum metal composite pipes.

Hostalen 4731 B is produced using LyondellBasell's latest-generation *Hostalen* Advanced Cascade Process (ACP) technology.



Fig. 7 – Underfloor heating, PE-Xa – courtesy of Schütz



Fig. 8 – Underfloor heating made from *Hostalen* 4731 B – courtesy of Kingbull



Fig. 9 – District heating pipe, PE-Xa – courtesy of Uponor

Heating and plumbing applications



Fig. 10 – Heating distribution system made from PP-R – courtesy of Aquatherm



Fig. 11 – Socket welded PP-R piping system – courtesy of Aquatherm



Fig. 12 – Fittings made from PB-1



Fig. 13 – Underfloor heating made from PB-1 – courtesy of Viega/ Gabo

Plexar tie-layer resins used in multi-layer pipe applications

Multi-layer pipe applications based on cross-linked polyethylene (PE-X) or PE-RT that contain aluminum or ethylene vinyl alcohol copolymer (EVOH) as barrier layers require high-performance adhesive layers. *Plexar* resins are LLDPE-based, tie-layer adhesives grafted with maleic anhydride.

LyondellBasell offers the following grades:

- *Plexar* PX3216 used in the adhesive layer between the inner layer and the aluminum layer of a metal composite pipe
- *Plexar* PX5335 used in EVOH, multi-layer pipe applications

Sales are done via selected distributors only.

Polypropylene random copolymers (PP-R)

Hostalen PP H5416 random copolymer grades are well-established in the field of piping systems for heating and plumbing.

Grades are available also in colored form.

Akoalit and Akoafloor, polybutene-1 (PB-1) used in heating, cooling and plumbing applications

PB-1 features the excellent properties of polyolefins – light weight, weldability, chemical resistance and low-noise transmission – with a unique combination of outstanding creep resistance and flexibility over a wide temperature range.

Akoalit PB-1 resins are used by LyondellBasell's customers for the production of flexible pressure piping systems for domestic hot and cold drinking water supply, surface heating and cooling, district heating, radiator connections and fittings.

Akoafloor is a new PB-1 based copolymer featuring improved flexibility, which makes it the ideal choice for surface heating and cooling pipe applications.

Wastewater management

Rapid urbanization and accelerating industrialization are causing increased water pollution and corresponding environmental threats. Modern wastewater systems made from polyolefins can provide solutions for sewage, stormwater run-off and rainwater infiltration systems.

PP-B used in sewage piping and infiltration systems

Customers in this special application section often select two of LyondellBasell's PP copolymer grades that demonstrate higher stiffness compared to traditional grades:

- *Hostalen* PP H2464
- *Hostalen* PP H2483 (PP-HM)

Hostalen PP H2483 is classified as PP-High Modulus (PP-HM) according to EN 1852-A1.

Soil sealing causes a loss of soil resources due to the covering of land for housing, roads or other construction work. *Hostalen* PP N2122 is a new, natural PP copolymer used in injection-molded rainwater regulating devices, which provide a sustainable solution for rain-water management.

HDPE used in gravity pipes for sewage and drainage applications

For corrugated sewage applications, *Alathon* L5332CP is often chosen by LyondellBasell's customers due to its excellent processing stability and high crush resistance. *Alathon* L5332CP conforms to AASHTO and Florida DOT corrugated pipe requirements.

HDPE used in conduit applications

Alathon L5040TC is used in telecommunications conduits, and offers a good balance of stiffness, toughness and ease of processing. *Alathon* HDPE grades are only available in North and South America.



Fig. 14 – Corrugated pipes made from *Hostalen* PP H2464 – courtesy of PLOMYPLAS



Fig. 15 – Infiltration system consisting of cubic units – courtesy of Wavin



Fig. 16 – Push connection, inline socketing
courtesy of PLOMYPLAS



Fig. 17 – Smooth sewage pipe with push fitting
courtesy of REHAU

Industrial applications

High molecular weight HDPE and PP are used in construction applications such as storage tanks for chemicals. LyondellBasell materials are used by customers in the extrusion of sheets and rods, and in compression-molded applications. Ultra high molecular weight PE (UHMW-PE) exhibits excellent abrasion resistance and toughness, which makes it the ideal choice for durable parts.

PP used in industrial applications, heating, cooling systems and plumbing

The *Hostalen* PP range includes a variety of PP families:

- PP-H (Homopolymer)
- PP-B (Block – Copolymer)
- PP-R (Random – Copolymer)

Hostalen PP H2150 and *Hostalen* PP H2250 36 homopolymer grades are the preferred resins used by customers for industrial pipes, sheets and fittings. *Hostalen* PP H1022/H2222 and *Hostalen* PP EPD60R heterophasic copolymer grades offer a combination of high stiffness and good impact resistance at sub-zero temperatures. They are selected by customers for industrial and corrugated pipes. *Hostalen* PP H2142 12 heterophasic copolymer is used by customers in mechanical-joint fittings according to ISO 14236. *Hostalen* PP H4122 is used by customers for solar heating systems of swimming pools.

UHMW-PE used in industrial applications

Lupolen UHM 5000 is a new UHMW-PE produced using LyondellBasell's latest-generation catalyst systems. The polymer is supplied in coarse, particle-size powder form. The grade can be considered for use in natural, compression-molded sheets. During the filling and closing of the press molds, the dust formation is considerably lower than the more common, fine UHMW-PE granules, offering improved handling.

Manufacturers predominantly produce semi-finished products in the form of large sheets, bars, rods and a variety of ram-extruded profiles. Because of its extremely high molecular weight, UHMW-PE resin cannot be transformed by conventional plastic processing techniques.

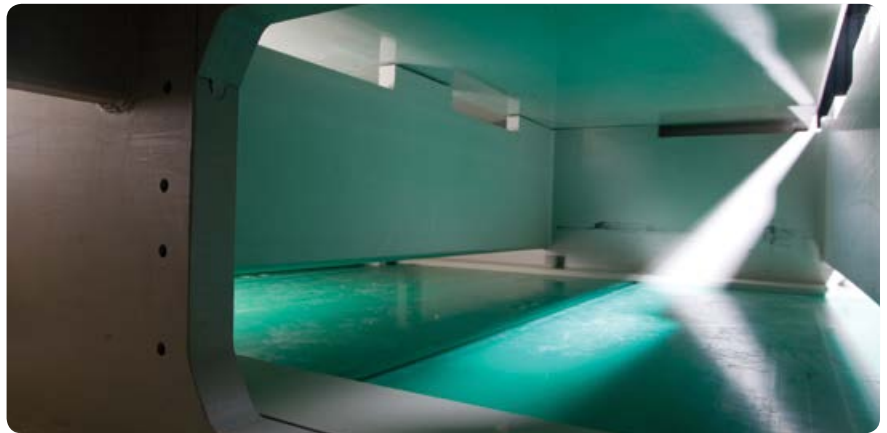


Fig. 18 – Storage tank for pickling of aluminum sheets (UHMW-PE and PP-H 100) courtesy of Steuler



Fig. 19 – Parts made from UHMW-PE

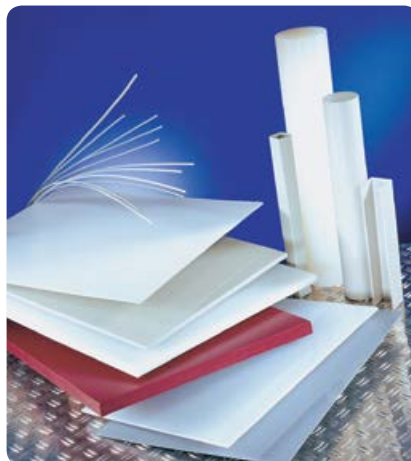


Fig. 20 – Semi-finished products made from PP courtesy of SIMONA



Fig. 21 – Semi-finished products made from HDPE courtesy of SIMONA

Main product portfolio

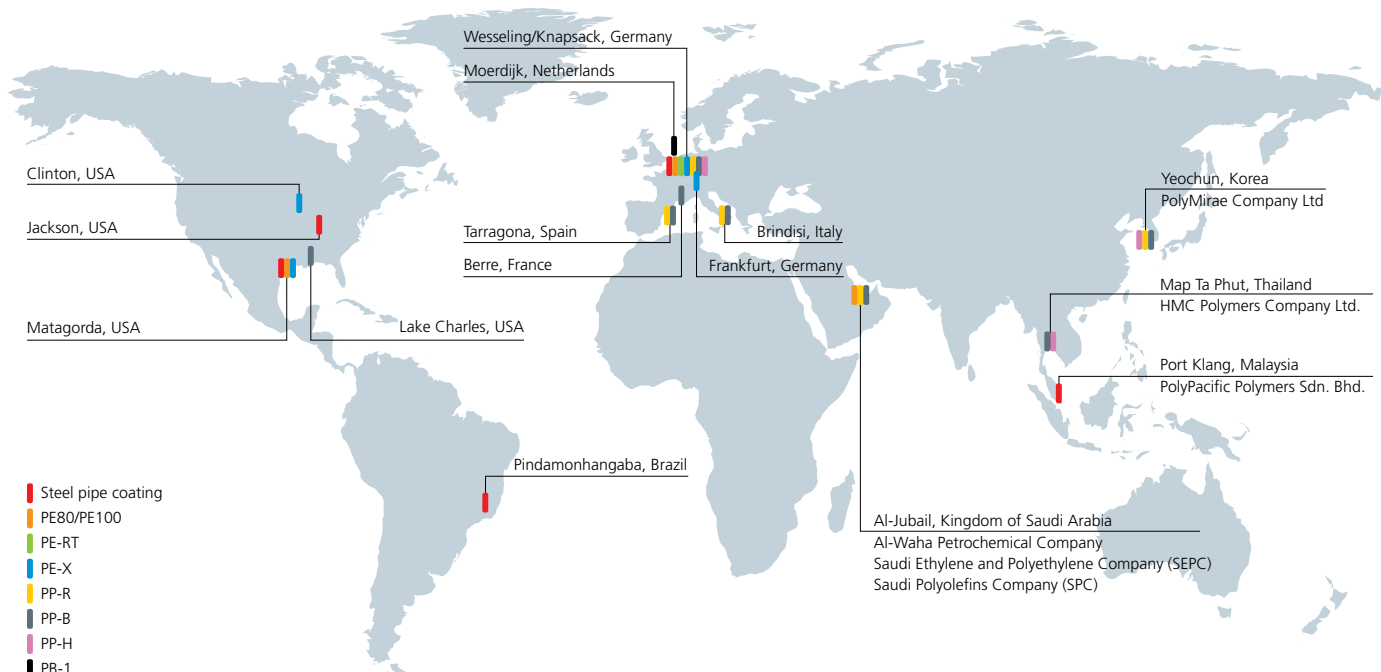
Typical customer applications

Typical application	Material	Grade	Availability
Drinking water distribution Gas distribution Other pressurized media (sewage, chemicals)	HDPE (PE100)	<i>Hostalen CRP 100 black</i>	worldwide
		<i>Hostalen CRP 100 blue</i>	
		<i>Hostalen CRP 100 orange</i>	
	HDPE (PE100-RC)	<i>Hostalen CRP 100 RESIST CR black</i>	worldwide
	HDPE (PE100-RC)	<i>Hostalen CRP 100 CR W blue</i>	
	HDPE (PE100)	<i>Hostalen CRP 100 XL black</i>	
		<i>Hostalen CRP 100 RD black</i>	
	HDPE (PE80)	<i>Hostalen GM 5010 T3 black</i>	
	HDPE (PE4710)	<i>Alathon L4904 (natural)</i>	Americas
		<i>Alathon L5008 HP (natural)</i>	
	HDPE (PE4608)	<i>Alathon L5008 (natural)</i>	
Transport of media in explosion-proof areas	HDPE	<i>Hostalen GM 9310 C black</i>	worldwide
Gravity sewage	PP-B	<i>Hostalen PP H2464</i>	worldwide
	PP-B, PP-HM	<i>Hostalen PP H2483</i>	
	HDPE	<i>Alathon L5332CP</i>	Americas
Conduits	HDPE	<i>Alathon L5040TC</i>	Americas
Heating and plumbing District heating Surface heating and cooling Radiator connection	HDPE (used in PE-Xa)	<i>Lupolen 5261 Z Q 456</i>	worldwide
		<i>Lupolen 5261 Z Q 456 B</i>	
		<i>Lupolen 5461 B Q 471</i>	
		<i>Lupolen 4961 D</i>	
	HDPE (used in PE-Xb)	<i>Lupolen 5031 L Q 449 K</i>	worldwide
		<i>Alathon M5370PX</i>	Americas
	HDPE (used in PE-Xc)	<i>Lupolen 4261 A Q 416</i>	worldwide
	PE-RT	<i>Hostalen 4731 B</i>	worldwide
	PP-R	<i>Hostalen PP H5416</i>	worldwide
		<i>Hostalen PP H5416 K</i>	Asia-Pacific
PB-1, copolymer	<i>Akoafloor PB R 509 brown</i>	PB-1 is not sold for pipe applications in NA	
PB-1, homopolymer		<i>Akoalit PB 4267 grey</i>	
		<i>Akoalit PB 4268 white</i>	
		<i>PB 4235-1 ivory</i>	
Tie-layer resins used in multilayer pipes in heating and plumbing	PE	<i>Plexar PX3216</i>	worldwide
		<i>Plexar PX5335</i>	

Global sourcing

Typical application	Material	Grade	Availability
Industrial pipes, sheets, rods, profiles, in-house soil and waste pipes	PP-H	Hostalen PP H2150	worldwide
		Hostalen PP H2150 304850 (grey)	
		Hostalen PP H2450	
		Hostalen PP H2250 36 (grey)	
		Hostalen PP H7350FLS 303064 (grey)	
	PP-B	Hostalen PP H1022	worldwide
		Hostalen PP H1022 12 (black)	
		Hostalen PP H2222 36 (grey)	
		Hostalen PP H4122 103220 (black)	
		Hostalen PP H2142 12 (black)	
UHMW-PE	Moplen EP332C	Asia-Pacific	
	Lupolen UHM 5000	worldwide	
Infiltration systems	PP-B	Hostalen PP N2122	worldwide
Steel pipe coating, top-coat	HDPE	Lupolen 4552 D black	worldwide
		Lupolen 4532 D (natural)	Americas
	PP-B	Moplen Coat EP/60 BIANCO	worldwide
Coating used in flexible, off-shore pipelines	PP	Hifax EKS157D NAT	worldwide
Adhesives used in steel pipe coating and flame spray powder	PE	Lucalen G 3710 E (pellets and powder)	worldwide
		Lucalen A 3110 M (pellets and powder)	
	PP	Hifax EP2 015/60 (pellets and powder)	worldwide
		Hifax EP5 10/60 BIANCO (pellets and powder)	
		Hifax EPR/60 BIANCO (pellets and powder)	

Worldwide availability



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