

LANXESS

Energizing Chemistry

Baypren®

Chloroprene, the prime all-round performer
for a wide range of applications

Edition 2008–06





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What is Baypren®?

About Baypren®

Chloroprene rubber (international abbreviation: CR) is a high-performance material with a wide diversity of applications. Along with Bayer's other synthetic rubber activities, Baypren® has been produced and distributed by LANXESS AG since 2005. In April 1957, Bayer became the first company to manufacture CR in Europe when it opened its production plant in Leverkusen, Germany. Since then, in addition to making ongoing improvements to the production process and developing products to match market requirements, the company has placed special emphasis on the development of new applications for Baypren®. Process and application oriented formulations have been developed for modern manufacturing methods and for a large number of end-uses. The formulations and the properties of the individual products have been constantly adapted to meet the mounting demands of processors and users.



Supply forms of Baypren®: solid rubber grades

Baypren® is the name of the LANXESS range of polymers based on 2-chloro-1,3-butadiene (chloroprene), which are manufactured by water-based emulsion polymerization in the presence of emulsifiers, activators etc. The importance of Baypren® is derived essentially from its attractive combination of key technical properties that are unattainable with other kinds of rubber at a comparable price. This has led to the development of many product variants to meet diverse requirements.

Articles made from appropriately formulated Baypren® compounds are suitable for moldings and extrudates of all types, reinforced hoses, roll covers, belting, including conveyor belts, air spring bellows, cable sheathing and insulation for low-voltage cables, sponge rubber, including open and closed-cell sponge rubber, corrosion-resistant linings, sheeting, fabric proofings and footwear (boots).

The flame-retardant behavior of Baypren® vulcanizates can be adjusted to meet special requirements. Chloroprene rubber (international abbreviation CR) is a high-performance material with a wide diversity of applications. Like the other activities in the field of synthetic rubber, Baypren® is since 2005 produced and distributed within LANXESS AG.

A key position – from the beginning until today

Bayer began producing chloroprene rubber in April 1957, and the first production line in Leverkusen had a capacity of 2,400 tonnes per year. The special-purpose rubber – which was first marketed under the trade name Perbunan® C and changed its name to Baypren® in 1968 – has occupied a key position on the world rubber market with its wide range of applications. Although Baypren® was initially manufactured in Leverkusen, production was gradually relocated in the early sixties to another Bayer site in Germany, namely Dormagen. In 1975, Bayer began chloroprene rubber production using a modern system based on its own raw materials when a large-scale plant was built at the Dormagen site to manufacture the monomeric chloroprene.

The latest major step in the history of chloroprene rubber took place in 2005 when the Baypren® rubber activities were transferred to LANXESS AG.

The history of Baypren®

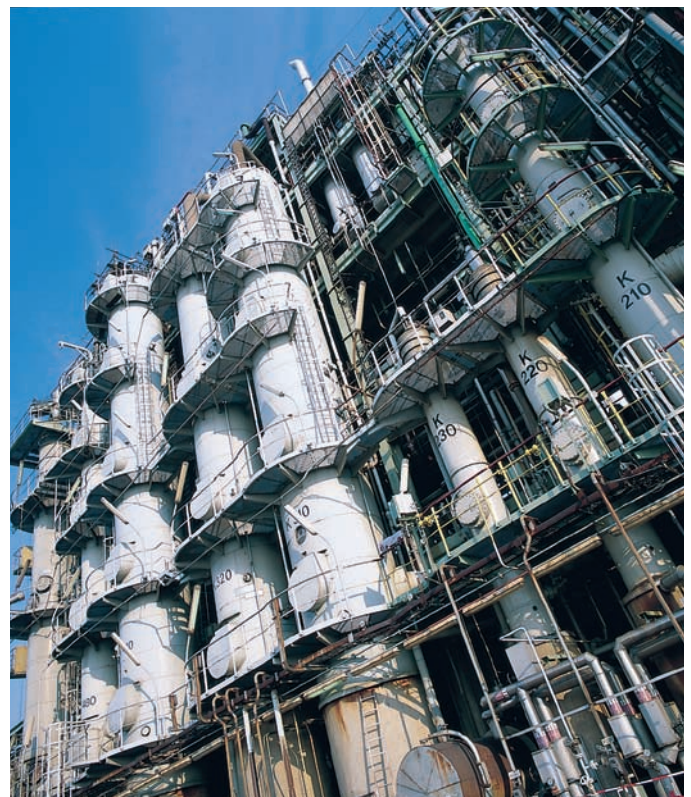
1957	Bayer begins the first European production of CR in Leverkusen, Germany under the trade name Perbunan® C (solid rubber, adhesive grades, latex)
1960	Gradual relocation of production to Dormagen, Germany
1968	CR renamed Baypren®
1975	Establishment of Bayer's own supply of monomer at Dormagen
2005	Transfer to LANXESS AG

Production with state-of-the-art PCS

The CR plant in Dormagen produces polychloroprene by the continuous emulsion polymerization process. This results in high-quality polymers for technical rubber, adhesive and latex applications. The monomers are produced on site by LANXESS based on the butadiene gas phase process, with the chlorine and butadiene delivered by pipeline from on-site suppliers.

Several investments have been made recently to increase capacity and improve the quality and safety of the production plant in Dormagen. A major project was the implementation of a new Process Control System (PCS) in the polymerization plant in which a central control room for the whole production unit was built. Since November 2006, the monomer production unit, the polymerization, the finishing and the creaming farm can be controlled from that control room, significantly increasing the efficiency of the CR plant. The state-of-the-art PCS plays a major role in improving the safety and quality of CR production.

The capacity of adhesive grade production will be increased before the end of 2007 through further investment in polymerization reactors. In addition, the capacity of the creaming farm has already been increased – including the creaming and degassing steps. Further investment in that area will double the capacity of our dispersion product line by mid-2008.



Part of the Baypren® production plant in Dormagen, Germany

Properties of Baypren®

Crystallization

A key distinguishing feature of the raw polymers is their tendency to crystallize. While virtually all liquids – water, for example – have a clearly defined temperature at which they undergo spontaneous crystallization on cooling (solidification point), some high molecular-weight products, such as natural rubber and a number of synthetic rubber grades, do not have a clearly defined crystallization point. Instead, they harden slowly as the temperature falls.

With these rubber grades, this is caused by a partial orientation of the macromolecules (crystallization). This hardening overlaps the increase in hardness that results from a drop in temperature (thermoplasticity). Hardening due to crystallization is a fully reversible process that can be performed by subjecting the crystallized material to heat or dynamic stress. Unvulcanized polymers and compounds produced from them display the most pronounced tendency to crystallize. Vulcanization, however, considerably slows down the extent of hardening resulting from crystallization in rubber articles.

The tendency of the polymers to crystallize can be influenced by appropriately controlled production processes. For this reason, rubber articles made from Baypren® grades with a low tendency to crystallize display virtually no increase in hardness due to crystallization even after exposure to low temperatures for long periods. In contrast, polymers with a particularly pronounced tendency to crystallize display a clear increase in hardness even after a relatively short time.

Modification

The properties of Baypren® vulcanizates are influenced by the type of modification of the raw polymer.

Effect of pre-crosslinking

- reduction of the elastic resilience (snappiness) of the raw rubber and uncured compound
- reduction of the die swell
- improvement in calendering behavior
- improvement of the surface smoothness of injection-molded articles
- improvement of the dimensional stability, e.g. of uncured profiles

Effect of sulfur modification

- facilitates mastication of the rubber, permitting the production of soft compounds with good building tack
- only MgO/ZnO required for vulcanization
- better tear resistance than standard grades
- better adhesion to fabrics than standard grades
- lower storage stability of raw polymers
- lower aging resistance of vulcanizates

Effect of XD (xanthogendisulfide) modification

- lower elasticity (less “nerve”) means easier processing (by calendering or extrusion)
- better mechanical properties than M-modified grades in the same formulation
- higher filler loadings possible



Properties of vulcanizates based on Baypren®

With the correct formulation, finished products made of Baypren® display the following characteristic properties in addition to their excellent rubber-elastic behavior:

- resistance to weathering, both in dry and humid climates.
- excellent combustion behavior
- average resistance to oils
- aging and heat resistance
- good tensile strength, tear and wear resistance
- high dynamic fatigue resistance
- resistance to water and a large number of chemicals over a long period
- good adhesion to suitably pretreated reinforcing substrates consisting of textiles, metals or glass fibers
- resistance to fungi and soil bacteria
- low gas permeability
- electrical properties sufficient for a large number of applications

The suitability of a Baypren® compound for a particular application should be established by relevant testing. Thanks to this excellent set of properties, Baypren® is being used for the production of highly stressed rubber articles in many sectors, primarily in the automotive industry, mechanical engineering, plant construction, ship-building, mining and mineral oil production. The properties of Baypren® vulcanizates are influenced by the type of modification of the raw polymer (i.e. precrosslinking, sulfur, xanthogendisulfid Effect of pre-crosslinking

Aging and heat resistance

Baypren® vulcanizates display excellent aging resistance, especially those with an optimized antioxidant content. They neither soften nor harden at high temperatures or over long periods of stressing and remain elastic and serviceable. The heat resistance of Baypren® vulcanizates is considerably better than that of natural rubber vulcanizates. It corresponds roughly to the heat resistance of nitrile rubber.

Weathering and ozone resistance

While vulcanizates produced from many other rubber types tend to crack and harden relatively quickly and degrade when exposed to weathering and/or ozone, suitably formulated Baypren® vulcanizates do not exhibit any significant deterioration, even after many years of exposure to atmospheric influences such as light, rain, industrial gases and oxygen. By extrapolating the change in mechanical properties after many years of weathering in an ozone-rich atmosphere, it can be concluded, on the basis of current technology, that technical rubber goods made of Baypren® can be expected to display sufficient elasticity for the majority of static applications (for example structural profiles) after more than 50 years.

Resistance to water and chemicals

By employing specially formulated compounds, it is possible to obtain Baypren® vulcanizates that are resistant to water, acids, alkaline solutions and a large number of industrial chemicals. Resistance to

hydrocarbons Baypren® vulcanizates possess sufficient resistance to mineral oils to make them suitable for many applications. Their resistance to swelling by mineral oils improves as the naphthenic and, in particular, the aliphatic content of the oil rises. They cannot match the very high swelling resistance to hydrocarbons of similarly formulated nitrile rubber vulcanizates, but their swelling resistance is considerably better than that of vulcanizates based on styrene-butadiene rubber, natural rubber or ethylenepropylene rubber.

Resistance to fungi and bacteria

Items made of rubber that are in contact with soil for long periods of time are susceptible to attack by soilborne bacteria and fungi. In the long term, this can lead to underground cables, for example, being destroyed. In contrast to the majority of other rubber types, Baypren® displays marked resistance to these microorganisms. This resistance can be enhanced still further through compound formulation.

Abrasion resistance

Baypren® vulcanizates are highly wear-resistant. Their abrasion resistance is similar to that of nitrile rubber.

Resilience

Suitably formulated Baypren® vulcanizates possess very good resilience although they do not attain the level of natural rubber. Very good resilience values are achieved in vulcanizates with a relatively high hardness.

Dynamic fatigue resistance

Baypren® vulcanizates are highly resistant to dynamic fatigue. Special grades are available to meet extremely stringent specifications, such as those applied to drive belts. The loss factor and hence the heat build-up under dynamic load are low.

Deformation properties

Baypren® vulcanizates have a low compression set over a temperature range of -10 to +145 °C. The low-temperature compression set is a key value employed in the assessment of vulcanizates for use in seals. At higher temperatures, where aging also plays a role, the compression set curves are lower than those of a large number of other elastomers.

Combustion behavior

Baypren® vulcanizates can be compounded for improved combustion behavior. The good combustion behavior of the polymer itself means that even stringent end user specifications can be met. Limiting oxygen index (LOI) values in excess of 50 % can be attained with Baypren®. The requirements placed on the flame retardance of conveyor belts for underground mining applications can be met with properly compounded Baypren®.

Properties of Baypren®

Low-temperature flexibility

The glass transition temperature of unfilled Baypren® polymers remains fairly constant at around -34 °C, almost irrespective of the polymers' tendency to crystallize. The brittleness temperature and the glass transition temperature of Baypren® vulcanizates can be reduced to below -50 °C by appropriate compound formulation. Where rubber parts made of Baypren® are required to remain flexible at low temperatures over long periods, grades with a low crystallization tendency are recommended.

Electrical properties

Baypren® is highly suitable for cable sheathing and, in many cases, for low-voltage insulation. It is recommended for use in cables that must have resistance to weathering, ozone, oil and aging as well as good combustion resistance.

Thermal conductivity and coefficient of thermal expansion

The thermal conductivity and coefficient of thermal expansion of Baypren® vulcanizates are comparable with other elastomers (see comparison on opposite page). The values obtained are, of course, largely determined by the compound formulation. The thermal insulation is also similar to that of the majority of plastics used in the construction industry today.

Gas permeability

Baypren® vulcanizates have a very low gas permeability, which is roughly equivalent to that of nitrile rubber (see comparison on opposite page).



Low-temperature flexibility over long periods of time

Comparison of the gas permeability coefficient of Baypren vulcanizates and other elastomers

Elastomers based on	Gas permeability 10^{-9} (cm ² s ⁻¹ bar ⁻¹)					
	Air		Nitrogen		Carbon dioxide	
	60 °C	80 °C	60 °C	80 °C	60 °C	80 °C
Chloroprene rubber (Baypren®)	70	120	45	80	580	760
Nitrile rubber (Perbunan® NT, Krynac®)	25 to 75	55 to 210	10 to 40	25 to 70	300 to 580	480 to 970
Natural rubber	250	400	180	330	1600	2100
Styrene-butadiene rubber (Krylene®)	150	260	110	200	1200	1500
Butyl rubber (Lanxess Butyl®)	20	50	15	35	130	290

Comparison of thermal conductivity according to VDE 0304/1 and the coefficient of linear expansion at 20-100 °C of Baypren vulcanizates and vulcanizates based on other polymers

Elastomers based on	Thermal conductivity (kJm ⁻¹ h ⁻¹ °C ⁻¹)	Coefficient of thermal expansion 10 ⁻⁶ (mm°C ⁻¹)
Chloroprene rubber (Baypren®)	0,84	130-150
Nitrile rubber (Perbunan® NT, Krynac®)	0,92	150
Natural rubber	0,78	180
Styrene-butadiene rubber (Krylene®)	0,88	180
Butyl rubber (Lanxess Butyl®)	0,65	130

Baypren® product range

Product	Crystallization	Mooney viscosity ⁽¹⁾ ML (1+4) 100 °C ⁽²⁾		Remarks	
General purpose grades					
M-modified					
Baypren® 110	very low	41 +/- 5	49 +/- 5		
Baypren® 112	very low	41 +/- 8			
Baypren® 210	medium	43 +/- 4	48 +/- 4		
Baypren® 211	medium	39 +/- 4			
Baypren® 230	medium	100 +/- 8	108 +/- 10		
XD-modified grades					
Baypren® 116	low	43 +/- 5	49 +/- 5	excellent mechanical	
Baypren® 126	low	70 +/- 7		properties due to formation	
Baypren® 216	medium	43 +/- 5	49 +/- 5	of perfect network	
Baypren® 226	medium	75 +/- 6			
Special grades					
Precrosslinked grades					
Baypren® 114	very low	62 +/- 10		especially designed for	
Baypren® 214	medium	55 +/- 6		extrusion applications	
Baypren® 215	medium	50 +/- 6			
Sulphur grades					
Baypren® 510	medium	42 +/- 5	50 +/- 5	suitable for mastication;	
Baypren® 611	low to medium	35 +/- 5	43 +/- 6	48 +/- 6	easy to process; for dynamic
Baypren® 711	low to medium	43 +/- 6	48 +/- 6		applications
Baypren® 712	medium	46 +/- 6			

Nomenclature of the Baypren solid rubber grades

First figure: Tendency to crystallize

1	=	low
2	=	medium
5+6+7	=	sulfur modified grades

Second figure: Viscosity

1	=	low („soft“ grades)
2	=	medium
3	=	high („hard“ grades)

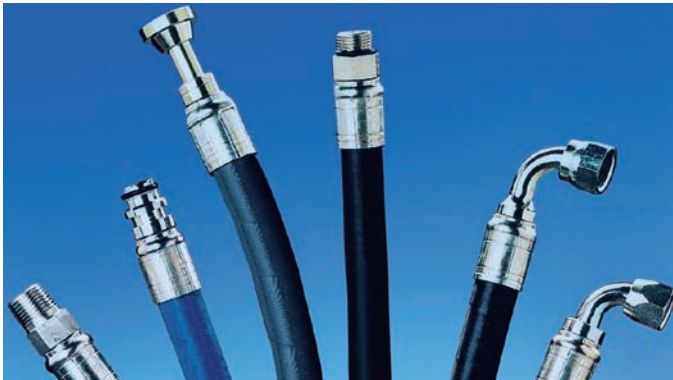
Third figure: Special properties

0	=	standard grades
1+2	=	special characteristics, e.g. regarding viscosity or crystallization
4	=	pre-crosslinked grades
5	=	pre-crosslinked and XD modified grades
6	=	XD modified grades

(1) unmassed (ISO 289)

(2) accordance with DIN 53 523 with no pre-treatment of samples

- Density (g/cm³) 1,23
- Standard Packaging: 25 kg paper bags with PE inner bags (0.05 mm thick, Vicat softening point DIN 53 460, ca. 75°C); 40 bags pallet = 1.000 kg net / 35 bags pallet = 875 kg net
- Also available: 20 kg PE bags; 50 bags per pallet = 1.000 kg net; 40 bags per pallet = 800 kg net
- Supply form: ivory-colored chips



Hoses

- Hydraulic hoses for high-pressure and ultra-high-pressure
- Reinforced hoses for medium pressure and low-pressure
- Brake hoses
- Oil and fuel hoses
- Hoses for use in the petroleum industry
- Floating hoses

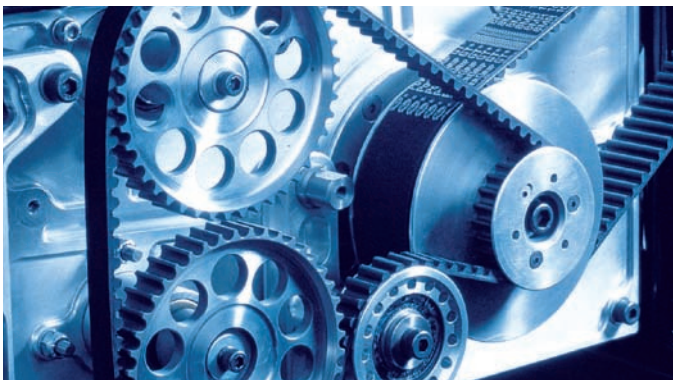
Molded parts

- Bellows and dust caps
- Axle boots
- Elbows
- Round section sealing strips, O-ring seals and flat seals
- Membranes
- Air springs
- Dampers and bearings with and without metal inserts, e.g. load bearing pads for high buildings and bridges
- Windshield wiper blades



Conveyor and transmission belts

- Power transmission belts for automotive and general industry
 - Timing belts
 - Poly-V-belts
 - Raw edge V-belts
 - Jacketed V-belts
- Conveyor belts with steel cord and textile reinforcement for underground mining applications, steel works, mineral processing plants and the chemical industry



Other

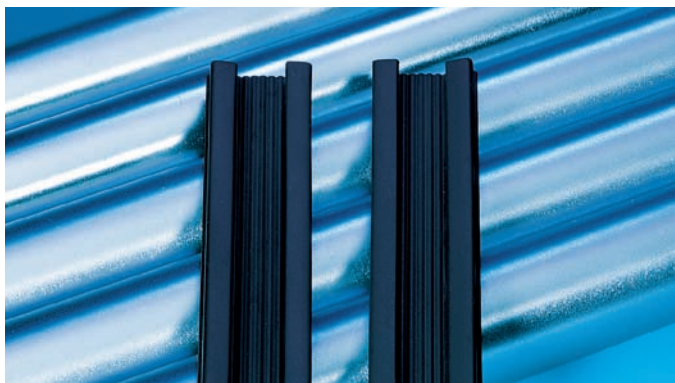
- Foam rubber sheet for wet suits and for the production of punched seals
- Covers for rollers in the printing industry and also in the textil and paper sectors
- Rubberized fabrics for all types of tarpaulins, containers and boats, and membranes in the automotive sector



Baypren® applications in the building and the cable and wire industry

Sealing strips

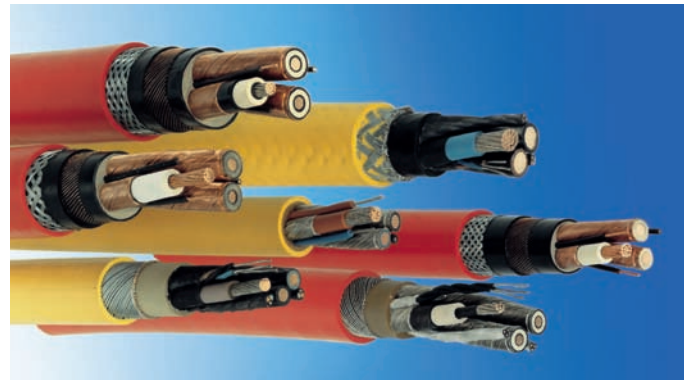
- Solid and microcellular rubber sealing strips for windows, doors and tailgates in the automotive sector
- Solid and microcellular rubber sealing strips for window and façade elements in the construction industry
- Expansion joint seals for civil engineering applications



Solid and microcellular rubber sealing strips for window and facade elements

Cables and wires

- Rubber-sheathed flexible cables for heavy duty in hoisting gear and transport and conveyor systems
- Rubber-sheathed flexible cables for heavy duty in underground and surface mining applications
- Rubber-sheathed flexible cables for use in dry and wet conditions on domestic appliances and light duty workshop equipment; suitable for moderate service conditions
- Rubber-sheathed flexible cables with suspension unit for elevators and conveyor systems; suitable for moderately severe conditions
- Trailing cables for use in dry and wet conditions and also in underground applications where service conditions are severe
- Theatre cables for mobile light fittings and light support structures
- Welding cables
- Flat flexible power and control cables for use in dry and wet conditions and also outdoors, especially for hoisting gear, transport systems, machine tools and processing machines; suitable for moderately severe conditions
- Flat flexible lighting cables



Cables and wires for use in dry and wet conditions

Adhesives

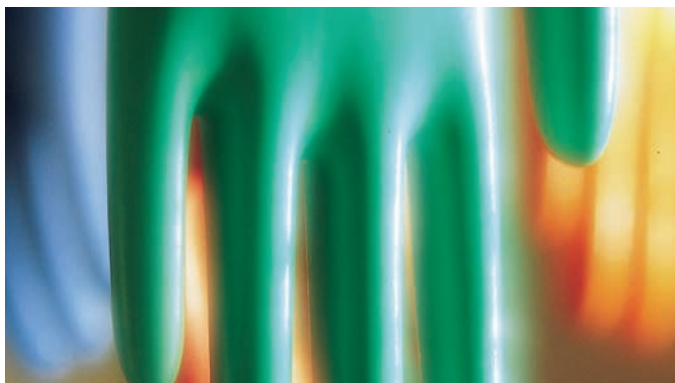
Baypren® 200 and Baypren® 300 grades have excellent solubility in many organic solvents and a pronounced tendency to crystallize, which makes them highly suitable for the production of contact adhesives. The contact adhesives are easy to process and bond very well indeed to a large number of materials. Another important factor for the popularity of Baypren® contact adhesives is their ability to form adhesive layers that are touch-dry after only a short drying period. When pressed together only lightly during their “contact tack time” or “open time” they immediately produce bonds with a measurable level of strength. Baypren® starts to crystallize straight away, producing a rapid increase in bond strength.

The Dispercoll® C (trademark of Bayer AG) aqueous dispersions were developed to meet the increasing demand for solvent-free adhesive systems. They combine ecological advantages with the structural properties inherent to Baypren® 200 and Baypren® 300 grades in polychloroprene.

The contact adhesives are widely used in the following industries:

- Shoe
- Automotive
- Furniture
- Building
- Do-it-yourself

If detailed information is required please contact our exclusive distributor **Bayer MaterialScience AG**



A wide range of latex applications

Latex applications

The brand name of Baypren® in latex applications is Lipren®.

Lipren® for modification of asphalt emulsions

Lipren® B modified anionic asphalt emulsions for flexible waterproof membranes against ground moisture, groundwater, backwater, and seepage water. Cationic asphalt emulsions modified with Lipren® K for road maintenance.

Waterproof membranes

- Roofing
- Foundations
- Cellars
- Tunnels

Road maintenance

- Chip seal
- Micro surfacing

Lipren® for dipping applications

Industrial and medical gloves

- Unsupported industrial gloves
- Textile supported gloves
- Examination gloves
- Surgical gloves

Medical devices

- Breathing bags
- Catheters
- Cushions

Balloons

- Meteorological balloons
- Toy balloons
- Football bladders

Lipren® for footwear and textile industry

Footwear

- Toe puffs
- Shoe insoles

Reinforcement materials

- Hoses
- Glass cord
- V-belts
- Air springs

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Make use of our experience!

Further information on Baypren® is available on the Internet at www.lanxess.com.

Inventing the future together

Research and development plays a key role at LANXESS. The Technical Rubber Products Business Unit has research and technical centers with testing facilities on almost every continent. Whether you are looking for better compounding ideas or are thinking about developing a new product, our experts will be happy to assist you.

For direct information, please contact our technical support service. Our Baypren® experts look forward to answering your questions.

Quality & Environmental Management

Baypren® is produced under strict control regarding safety, environmental protection and quality. The whole supply chain, from production to customer service, is covered by ISO 9001 and ISO 14001 certification.

Product safety

Relevant safety data and references as well as the necessary hazard warning labels can be found in the Material Safety Data Sheet.

Food contact

Information concerning FDA and BfR compliance can be obtained on request from the Health, Safety, Environment and Quality Department (HSEQ) of Lanxess.

As with any product, use of the products mentioned in this publication in a given application must be tested (including field testing, etc.) by user in advance to determine suitability.

Health and Safety Information:

Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the LANXESS products mentioned in this publication. For materials mentioned which are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets and product labels. Consult your LANXESS representative in Germany or contact the Health, Safety, Environment and Quality Department (HSEQ) of LANXESS Germany or - for business in the USA - the LANXESS Product Safety and Regulatory Affairs Department in Pittsburgh, PA.

Regulatory Compliance Information: Some of the end uses of the products described in this publication must comply with applicable regulations, such as the FDA, BfR, NSF, USDA, and CPSC. If you have any questions on the regulatory status of these products, contact your LANXESS Corporation representative, the LANXESS Regulatory Affairs Manager in Pittsburgh, PA or the Health, Safety, Environment and Quality Department (HSEQ) of LANXESS Germany.

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LANXESS

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