ARLANXEO

Performance Elastomers

PERFORMANCE POLYMERS FOR ADHESIVES AND SEALANTS

PRODUCT PORTFOLIO

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INTRODUCTION

ARLANXEO is a world-leading synthetic rubber company with sales of around 3.2 bn € in 2018, about 3,900 employees and 20 production sites in nine countries. ARLANXEO was established in April 2016 as a joint venture of LANXESS and Saudi Aramco. On January 1st, 2019, Saudi Aramco became the sole owner of ARLANXEO.

ARLANXEO products for the adhesive industry

Headquartered in Maastricht, Netherlands, the company's core business is the development, manufacturing and marketing of high-performance synthetic rubber. These polymers do not only find their application in technical rubber goods and tires, but also in the adhesive industry as raw materials or as modifiers for adhesives and sealants. Elastomers can give the adhesive more flexible bond lines, a better wetting and tackiness, can improve impact resistance or may act as a viscosity modifier and toughener. ARLANXEO offers a broad range of polymers with different chemical structures, polarities and molecular weights, that can be used in many versatile adhesive applications.

Contact adhesives based on Baypren®

For example, ARLANXEO's butyl rubber X_Butyl® is used for mastics and sealants or in pressure sensitive adhesives (PSA). Ethylene vinyl acetate copolymers Levamelt® (40 – 90 wt% vinyl acetate content) can be used in PSAs or as modifiers in reactive adhesives and hot melts. ARLANXEO`s nitrile rubbers, namely Perbunan®, Krynac® and Baymod® N, are used in contact adhesives, sealants or as impact modifiers. Baypren®, the polychloroprene from ARLANXEO, is a perfectly suitable raw material for contact adhesive and can additionally be used in sealants or as a modifier for reactive adhesives.

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Contact adhesives

The fundamental benefit of contact adhesives over reactive adhesive systems is their ability to create high bond strengths instantly after bonding. In contrast to the reactive adhesives, the bonded parts can be used immediately. Fixation of the substrates until the cure is finalized is not needed. This makes processing of the contact adhesive very convenient for the operator. With polychloroprene, acrylonitrile and ethylene-vinyl acetate copolymers ARLANXEO is offering a broad portfolio of raw materials and modifiers for contact adhesives.

Baypren® is a state-of-the-art raw material for solvent borne contact adhesives. The Baypren® portfolio for adhesive applications consists of two product lines, differing in their rate of crystallization. The fast crystallizing 300 grades give contact adhesives with high initial strength, high final strength and a rapid bond formation. These adhesives are especially useful in industries with fast production cycles like the shoe industry. In cases where a high initial bond strength is not needed (e. g. flooring or roofing applications), the medium fast crystallizing Baypren® grades of the 200 line can be used. They prolong the open time of the adhesive, enhancing processing safety and give even softer, more flexible bond lines for the joining of flexible substrates like rubber, foamed material or leather. The medium fast crystallizing Baypren® grades can be used both on their own or in combination with fast crystallizing Baypren® grades. Additionally grades with different viscosities can easily be blended, allowing the formulation of an adhesive with a well-fitting viscosity and an optimized crystallization behavior for the distinct application.

Footwear sector – one of the industries where contact adhesives are indispensable

Baypren® grades of both product lines can be directly dissolved, without prior mastication. However, to improve processing of the adhesive, the polychloroprene can be milled before solvation to give smooth, easy to apply adhesives. The thiuram modified Baypren® grades are best suited for this application.

If properly formulated, adhesives based on Baypren® can be used in combination with isocyanates in two part adhesives, resulting in adhesives with higher cohesive strength, heat stability and adhesion to difficult-to-bond substrates, in comparison to one part adhesives. Grades from the 300 product line are also suitable for grafting with methyl methacrylate (MMA). By grafting with MMA, the adhesion to plasticized polyvinylchloride (PVC) is improved. If the grafting reaction is not possible, the adhesion to plasticized PVC can significantly be enhanced by addition of Levamelt® to the adhesive formulation. Due to the good compatibility to the plasticizer of the PVC, especially Levamelt® 450 and 500 can be used to prevent adhesive failure of the bond.

Nitrile butadiene rubber (NBR) from ARLANXEO is available in various forms under the tradenames Perbunan®, Krynac® and Baymod® N. NBR is a copolymer of butadiene and acrylonitrile with an acrylonitrile content of 18 up to 50 wt% allowing to adjust the polarity and therefore the compatibility with solvents as well as the low temperature flexibility of the material. It is available in bale (Perbunan® and Krynac®) or powder (Baymod® N) form to fit into any adhesive production process.

Since NBR is not crystallizing like polychloroprene, contact adhesives made of NBR have a lower cohesive strength and a longer setting time. But compared to natural rubber the final strength is higher. To increase the cohesive strength, the solvent based NBR adhesive can be cured. Depending on the accelerator system NBR can be cured either at room temperature or at elevated temperatures. The addition of different components gives freedom to adjust the desired properties, e.g. resins for high adhesion strength, isocyanates for improved fabric bonding, zinc oxide for increased tack or plasticizers for highest low-temperature flexibility.

Nitrile based contact adhesives are recommended for a wide range of applications including leather, plastics (especially

APPLICATIONS

PVC), cork, (coated) fabrics, cotton, wood, paper, composites and foams. Linear as well as pre-crosslinked grades are available with a wide range of Mooney viscosities from 30 up to 120 MU which helps to improve the strength of the adhesive, since higher viscosity results in higher bonding strength. The processing may require milling prior to adhesive preparation to reduce the cement viscosity. High levels of acrylonitrile give superior bonding properties.

Raw materials for contact adhesives: Perbunan® and Krynac®

In addition to adhesive applications with nitrile rubber only, blends of nitrile rubber and phenolic resins are widely used as adhesives. The acrylonitrile content should be at least 28 wt% to achieve proper compatibility to the resin and sufficient structural strength; higher acrylonitrile contents give superior film and bonding properties. The higher the phenolic resin ratio, the higher the bond strength. These structural adhesives are widely used in aerospace, automotive, machinery and construction industry such as airframe bonding, fuel tank sealing and fiber glass sandwiches. In addition to sulfur cure, the curing of the adhesive with peroxides is possible, yielding adhesives used for example in insulating applications for printed circuits.

NBR can be functionalized to produce carboxylated NBR (XNBR). Thanks to its carboxylic acid moieties, Krynac® X grades provide very good cohesive strength and improve the properties of cement preparation such as film-forming. They are used alone or in combination with phenolic resins to obtain maximal bonding particularly in rubber-to-metal and in metal-to-metal adhesives. The adhesion to many other non-metal surfaces is also increased, including polyamides, paper fibers and fabric, due to hydrophilic interactions with cellulose.

Some acrylonitrile grades in the market can have impurity amounts up to 5 wt%. “Clean NBR” grades from ARLANXEO contain less than 1 wt% of these residues, which makes these grades particularly useful for transparent applications where any sediment could be an issue.

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Pressure sensitive adhesives

Today, a world without pressure sensitive adhesives (PSA) is inconceivable. For adhesive tapes, labeling, medical dressing, graphic films or also in the automotive sector, PSAs have found numerous applications. For example, tapes based on pressure sensitive adhesives are instantaneously tacky and adhere to all kinds of different surfaces at room temperature just by applying a certain amount of pressure on the tape. Depending on the PSA the adhesive is designed to adhere permanently or only temporarily on the surfaces.

With Levamelt® – ARLANXEO's ethylene vinyl acetate copolymer which is dedicated to the adhesive industry, both temporary and permanent adhesion is possible. Levamelt® is a pure viscoelastic material that has a vinyl acetate content between 40 – 90 wt% with melt flow indices (MFI) between 2-35 g/10min. Due to its higher vinyl acetate content, the polymer is much more polar compared to conventional EVAs which are mostly used for hot melts. With Levamelt® peel forces are adjustable just by choosing the proper vinyl acetate content. That means Levamelt® can be used in low peel applications where an easy removal of the film is crucial. Depending on the formulation, medium to high peel force applications are also possible with Levamelt®.

If an easy film removal on polar substrates is important, Levamelt® is the polymer of choice. For all kinds of protective films where a residual free removal of the film is important Levamelt® as an adhesive is well suited. Levamelt® can be used as an adhesive even for delicate surfaces like car coatings where a migration of a plasticizer or tackifier will harm the surface. Here formulations based on Levamelt® without any plasticizer or tackifier will deliver sufficient adhesion for a temporary protective film.

For medical application, Levamelt® can be used as a temporary skin adhesive. Remarkably, adherence of the substrate to the skin is possible without any damage to the skin by properly adjusting the peel forces.

X_Butyl®'s tack, ageing resistance and low permeability make it the ideal polymer for a variety of adhesive and sealing applications. Our X_Butyl® products are used in adhesive formulations for transparent tapes, hot melt pressure sensitive adhesives, mastic for pipe wrap tapes, vinyl floor tile adhesives and roofing adhesives. They are also used for self-fusing, semi-conducting electrical splicing tapes, eliminating the need for separate adhesive coats.

PSA – easy peel applications with Levamelt®

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Sealants

The main difference between adhesives and sealants lies in the purpose of their application. Adhesives transfer forces from one substrate to the other whereas sealants fill the gap between the substrates to block the permeation of liquids or gases through the joint. Sealants therefore usually have a lower modulus than adhesives. Apart from sealants, which are elastic materials, caulks that have no or only minor elastomeric properties are also used. With raw materials from ARLANXEO, the manufacturing of both classes is possible. Sealants and caulks are commonly either supplied as mastics, that can be applied by cartridges, or in the form of tapes.

ARLANXEO's regular butyl rubbers are used in many sealant applications. Applications include roof/chimney, wall applications, concrete pipe sealants, automotive assemblies, cable and wiring, and corrosion protection for steel pipelines.

In particular for hot melt sealant application, ARLANXEO offers X_Butyl® regular butyl grades RB 301 and RB 100 in the insulated window glass industry. These hot melt butyl sealants can be primary or secondary sealants and provide the necessary requirements for the insulated glass industry such as durable adhesion to the substrates, barrier to water vapour, excellent retention of barrier gas (e.g. Argon) and heat resistance.

Apart from butyl rubber, ARLANXEO is offering with polychloroprene (Baypren®) a base material for solvent borne mastics. Special pre-crosslinked Baypren® grades like Baypren® 214 are giving these formulations good non-sagging properties. The polarity of the polychloroprene enables a good adhesion to a variety of substrates. Because of the good weathering resistance of polychloroprene, mastics based on this material are mainly used in outdoor applications, for example for the fixing of leakages of gutters.

Acrylonitrile butadiene polymers have the best resistance to oil, fuel and fat compared to other elastomers (cf. chapter contact adhesives). Sealants made of ARLANXEO's NBR show a significantly improved oil resistance. Therefore, NBR can be used in many applications such as industrial sealants, automotive sealants and gap fillers. The abrasion resistance is excellent. The gas impermeability depends on the acrylonitrile content, however it is overall very low and at higher acrylonitrile-levels comparable to butyl rubber. NBR is generally used for liquid, pasty and expanding sealants, e.g. glazing and caulking compounds for wood, metal and masonry, and is common where solvent and fuel resistance is needed, e.g. asphaltic airfield joints. Krynac® and Perbunan® sealants modified with phenolic resins are used for example in aircrafts to seal tanks against leakage.

In addition to linear NBR grades with different molecular weights, ARLANXEO offers the pre-crosslinked NBR grades which are also perfectly suitable for sealant applications. For easy processing, Baymod® N powdered grades are available for both linear and pre-crosslinked grades.

X_Butyl® for sealants brings insulation to work

APPLICATIONS

Hotmelts

Hotmelts are easy to process and widely applied in the adhesive industry for woodwork, bookbinding and packaging solutions. The properties of a hotmelt are mainly governed by the crystallinity of the base polymer. Hotmelts are adhesive systems that are melted during processing and develop cohesive strength upon cooling. The melting of the crystallinity and thus the reduction of the viscosity improves the wetting of the substrate but at the same time the polymer shows only reduced cohesive strength. By cooling crystallinity is restored, final properties are attained and the cohesive strength is increased again. This basic principle of how hotmelts work seems to be rather simple – nevertheless recipes of hotmelt formulation are often complex. As base polymers EVA, PA, PO, PES or PUR can be used in these formulations depending on the required softening point. Mostly ethylene vinyl acetate copolymers are used for hotmelts. Usually polymers with a vinyl acetate content below 40 wt% are applied, but also copolymers with a higher vinyl acetate content can be used either as a base polymer or as an additive for hotmelt formulations.

Levamelt® grades with rather low vinyl acetate content between 40 - 50 wt% are especially suitable. These grades offer a medium degree of crystallinity combined with a comparably high polarity. Levamelt® is used in these formulations as a single base polymer or also in combination with other polymers. Here Levamelt® acts as a viscosity modifier or can help to adjust the melting properties.

Hotmelts modified with Levamelt®

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Methyl methacrylate adhesives

Methyl methacrylate (MMA) adhesives belong to the class of reactive adhesives that harden via a radical polymerization mechanism. They exhibit fast curing, good adhesion to various substrates and high adhesive strength. But unmodified MMA adhesives cure to hard, brittle films. To toughen the bond line usually elastomeric materials are added to the adhesive formulation. During the formulation of the MMA adhesive, the elastomer is dissolved in the acrylate monomers, increasing the viscosity of the adhesive, to give a formulation that can easily be applied. As the curing proceeds, the elastomer is incorporated into the growing MMA-network, improving the network density and giving a more flexible bond line that resists peel and cleavage stresses as well as impact. As elastomeric components for MMA adhesives ARLANXEO is offering Baypren® and Levamelt®. The chloroprene rubbers of the Baypren® series are available with different chain lengths to adjust the viscosity of the MMA adhesive and the properties of the cured bond line. With the Levamelt® (ethylene vinyl acetate copolymers) grade line ARLANXEO additionally provides a halogen free alternative.

MMA adhesives – more flexible with Baypren® and Levamelt®

Epoxy resin adhesives

Epoxy adhesives are known for their excellent tensile, compressive and flexural strength. They represent a class of reactive adhesives which are widely used in the electronic, construction, automotive and aeronautic industry. Typical basic epoxy formulations comprise an epoxy resin which is mixed together with a hardener. Numerous classes of hardeners and epoxy resins were developed over time, enabling customized epoxy adhesives. Like most other thermosettings also epoxy adhesives are brittle. Toughening are frequently used to reduce the brittleness of epoxy thermosetting and here is where ARLANXEO's elastomers come into play.

Due to its carboxylic acid moieties the carboxylated NBR (XNBR, Krynac® X) represent a unique material to bond to a variety of epoxy systems. By forming covalent bonding to the epoxy matrix a superior adhesion results. Some important application areas of epoxy resins modified with Krynac® X are laminating and structural bonding in aircraft applications, printed circuit boards and adhesives for electronics. In epoxy resins XNBR gives elasticity, resilience and good low temperature properties in addition to the excellent strength. Levapren® NPG was recently introduced and is the only polymer within the Levamelt®/Levapren® portfolio which is functionalized. The polymer has all the properties (e.g. polarity) of a conventional Levamelt® 600, but additional epoxy groups are incorporated. Levapren® NPG is designed to work as a toughener in epoxy-adhesives, here the epoxy group of the elastomer participates in the hardening process of the epoxy resin. Furthermore Levapren® NPG acts as a modifier in reactive adhesives and enhances the adhesion of coatings to fabrics.

Epoxy resin adhesives – toughened by Levapren® NPG

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Baymod® N, Krynac®, Perbunan®

Grade	Special feature	Acrylonitrile content (%)	Mooney viscosity[1] (MU)	Viscosity [mPa·s] 10 wt% solution viscosity in MEK
Krynac® – standard NBR grades				
Krynac® 2645 F		26	45	approx. 100
Krynac® 2850 F		27.5	48	approx. 100
Krynac® 3330 F		33	30	approx. 50
Krynac® 3370 F		33	70	approx. 150
Krynac® 33110 F	Highest strength	33	110	approx. 500
Perbunan® – standard NBR grades				
Perbunan® 2846 F	Clean	28	45	approx. 100
Perbunan® 28120 F	Highest strength	28	120	approx. 700
Perbunan® 3446 F	Clean	34	45	approx. 100
Perbunan® 3481 F	Clean	34.7	78	approx. 250
Perbunan® 3945 F	High oil resistance	39	45	approx. 100
Perbunan® 4456 F	Clean, very high oil resistance	44	55	approx. 100
Krynac® XL – pre-crosslinked NBR grades				
Krynac® XL 3355	Pre-crosslinked	33	55 (massed)	
Krynac® XL 3375 VP	Pre-crosslinked	33	75 (massed)	
Krynac® X – carboxylated NBR grade				
Krynac® X 740	7 wt% Carboxylic acid content	26.5	38	approx. 100
Baymod® N – linear and pre-crosslinked NBR powder grades				
Baymod® N 34.52	Powdered	33	45	approx. 50
Baymod® N 34.82	Powdered	33	70	approx. 100
Baymod® N XL 33.61	Pre-crosslinked, powdered	33	55 (massed)	

[1] ML (1+4) 100°C unmassed (ISO 289-1)
MU (Mooney units)

Supply form

Perbunan® and Krynac® are supplied as 25 kg bales, Baymod® N as powder in 25 kg bags.

Baymod® N – powdered NBR grades

Your contact to Baymod®, Perbunan®, Krynac® experts: nbr@arlanxeo.com; webpage: nbr.arlanxeo.com

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Baypren®

Fast crystallizing grades

Grade	Chip-thickness [mm]	Viscosity [mPa·s] 10 wt% solution in toluene
Standard grades		
Baypren® 310-1	approx. 2	70 – 220
Baypren® 310-2	approx. 2	220 – 380
Baypren® 320-1	approx. 2	350 – 550
Baypren® 320-2	approx. 2	550 – 810
Baypren® 330-1	approx. 2	700 – 1,000
Baypren® 330-2	approx. 2	900 – 1,400
Baypren® 340-1	approx. 2	1,130 – 1,800
Baypren® 340-2	approx. 1	1,600 – 2,500
Baypren® 350-1	approx. 1	2,200 – 4,000
Baypren® 350-2	approx. 1	2,500 – 5,300
Thiuram modified grades		
Baypren® 321-1	approx. 2	350 – 550
Baypren® 321-2	approx. 2	550 – 810
Baypren® 331-1	approx. 2	700 – 1,000
Baypren® 331-2	approx. 2	900 – 1,400

Medium fast crystallizing grades

Grade	Chip-thickness [mm]	Viscosity [mPa·s] 10 wt% solution in toluene
Standard grades		
Baypren® 213-1	up to 10	70 – 220
Baypren® 213-2	approx. 2	220 – 380
Baypren® 223-1	approx. 2	350 – 550
Baypren® 223-2	approx. 2	550 – 810
Baypren® 233-1	approx. 2	700 – 1,000
Baypren® 233-2	approx. 2	900 – 1,400
Baypren® 243-1	approx. 2	1,130 – 1,800
Baypren® 243-2	approx. 2	1,600 – 2,500
Baypren® 253-1	approx. 2	2,200 – 4,000
Baypren® 253-2	approx. 2	2,500 – 5,300
Pre-crosslinked grade		
Baypren® 214	up to 10	50±6 MU[1]

[1] ML (1+4) 100°C unmassed (ISO 289-1)
MU (Mooney units)

Supply form

Baypren® is supplied in form of chips with about 2 cm length, 1 cm width and a thickness of 1-10 mm.
The chips are talcum coated and packed in 25 kg bags.

Thickness of chips up to 10 mm:
Baypren® 213-1 and
Baypren® 214

Thickness of chips approx. 2 mm:
Baypren® 213-2 to 253-2 and
310-1 to 340-1

Thickness of chips approx. 1 mm:
Baypren® 340-2 to 350-2

Your contact to Baypren® experts: baypren@arlanxeo.com; webpage: baypren.com

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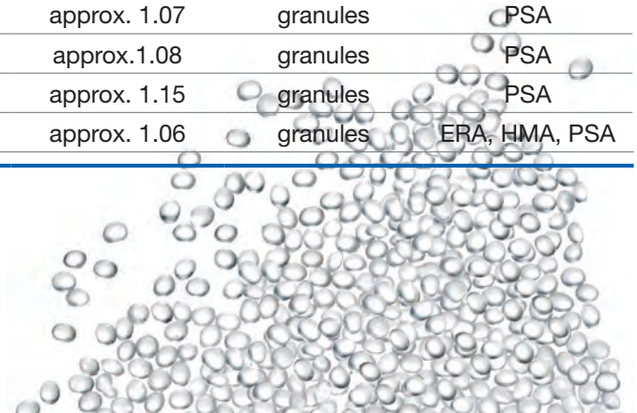
Levamelt®, Levapren®

	VA Content (weight in %)	Melt Flow Index (g/10min)[2]	Specific Gravity	Supply Form[3]	Adhesive
Levamelt® 400	40±1.5	3±2	approx. 0,98	granules	HMA, PSA
Levamelt® 450	45±1.5	3±2	approx. 0.99	granules	HMA, PSA
Levamelt® 452	45±1.5	10±5	approx. 0.99	granules	HMA, PSA
Levamelt® 456	45±1.5	25±10	approx. 0.99	granules	HMA, PSA
Levamelt® 500	50±1.5	2,75±1.25	approx. 1.00	granules	HMA, PSA
Levamelt® 600	60±1.5	2,75±1.25	approx. 1.04	granules	PSA
Levamelt® 686	68±1.5	25±10	approx. 1.06	granules	PSA
Levamelt® 700	70±1.5	4±2	approx. 1.07	granules	PSA
Levamelt® 800	80±1.5	4±2	approx.1.08	granules	PSA
Levamelt® 900	90±1.5	4±3	approx. 1.15	granules	PSA
Levapren® NPG VP[1]	approx. 57	approx. 4	approx. 1.06	granules	ERA, HMA, PSA

ERA = epoxy resin adhesive
HMA = hot melt adhesive
PSA = pressure sensitive adhesive

[1] VP = trial product
[2] Measured at 190 °C/2.16 kg
[3] Packaging 25 kg



Your contact to Levamelt® experts: levamelt@arlanxeo.com; webpage: levamelt.com

X_Butyl®

Name	Mooney [MU]	Unsat [mol%]	Type
X_Butyl® RB 100	33	0.90	regular butyl
X_Butyl® RB 301	51	1.85	regular butyl
X_Butyl® RB 402	33	2.25	regular butyl

Your contact to X_Butyl® experts: webpage: tsr.arlanxeo.com

Trial Product:
(VP = Versuchsprodukt = trial product). The information contained herein is merely preliminary. Testing as to properties and applications is not final. Further information, including data which could change or add hazards with use, may be developed by the manufacturer, the user or a third-party institute. Such information may be needed to properly evaluate or use this product. Use is undertaken at the sole risk of the user.

Quality & Environmental Management:
All ARLANXEO products are 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 possibly necessary warning labels are to be found in the corresponding safety data sheets.

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 ARLANXEO products mentioned in this publication. For materials mentioned which are not ARLANXEO 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 us through your ARLANXEO representative.

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 ARLANXEO representative.
The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations, is beyond our control.
Therefore, it is imperative that you test our products, technical assistance and information to determine to your own satisfaction whether they are suitable for your intended uses and applications. This application-specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by us. Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale. All information and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance and information.
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ARLANXEO
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