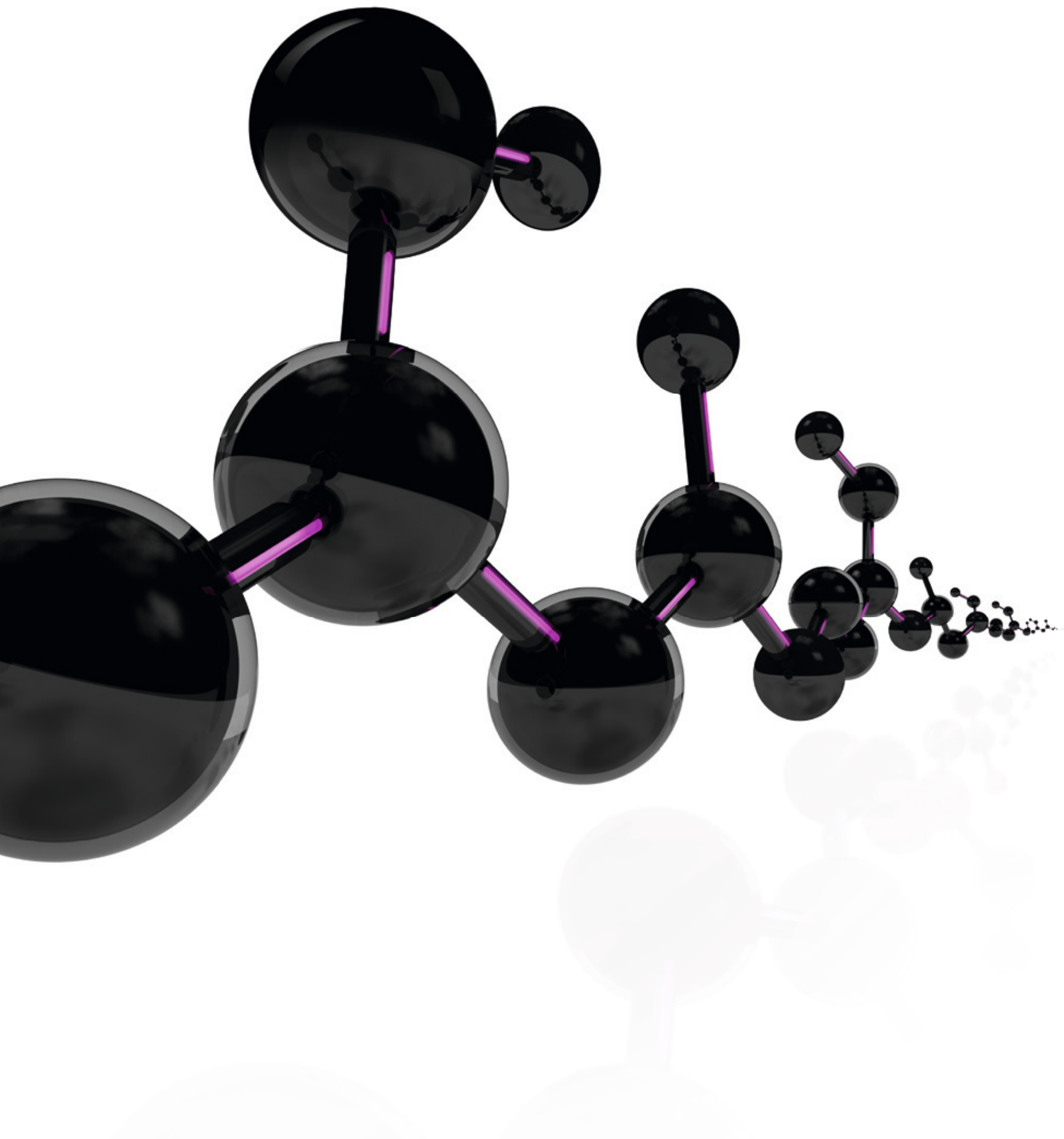
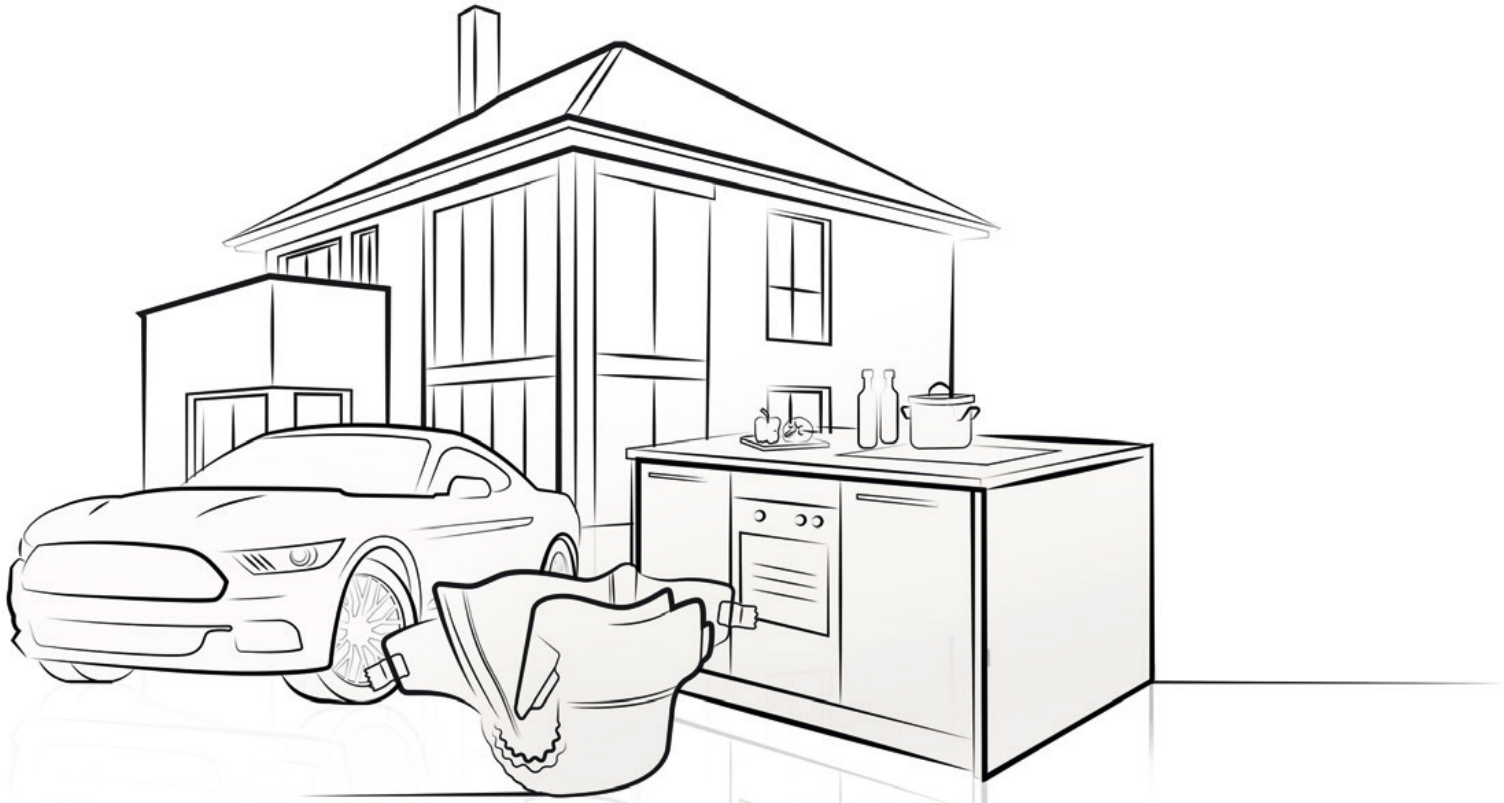
We design polymers.

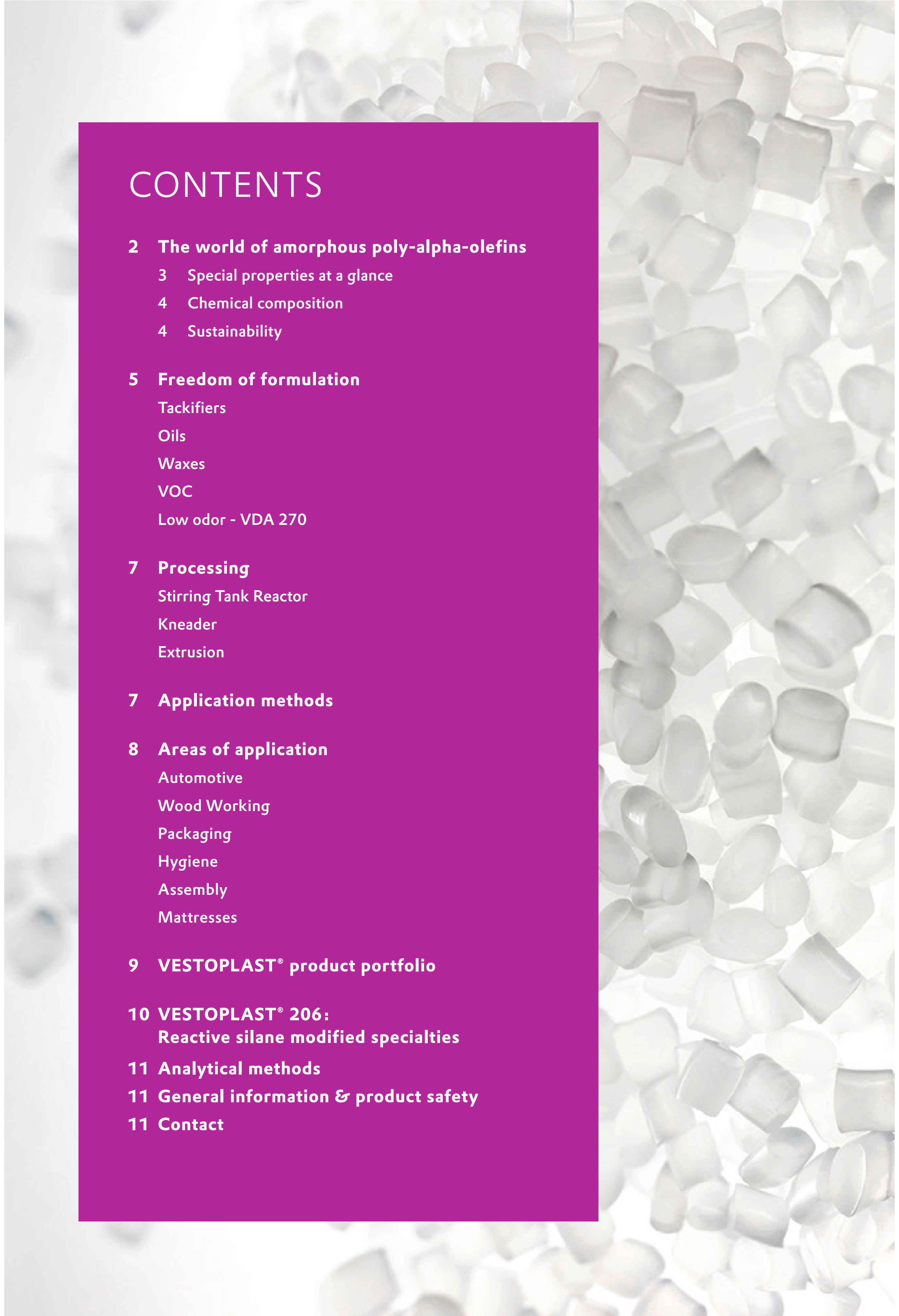
Discover our world of **Amorphous poly-alpha-olefins**





VESTOPLAST®

EVONIK
Leading Beyond Chemistry

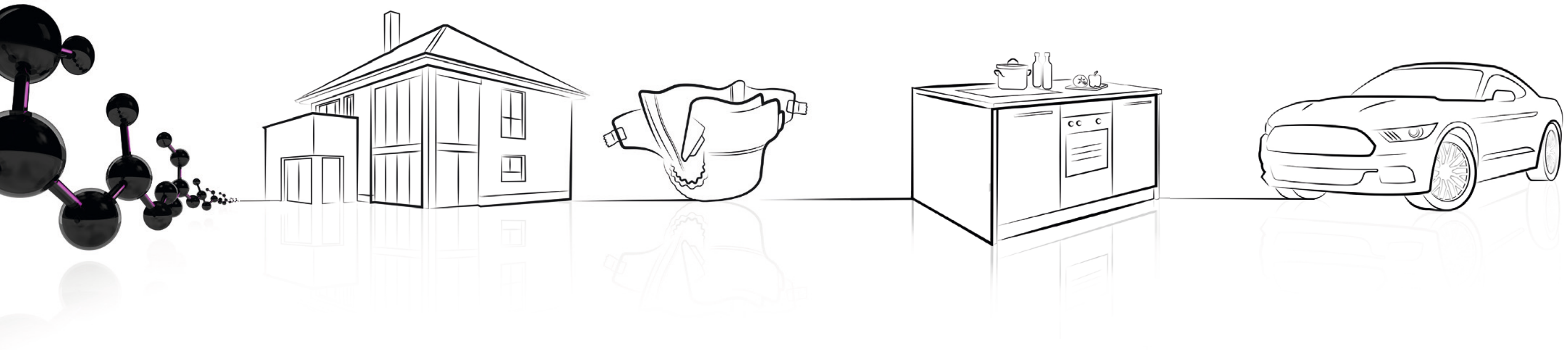


CONTENTS

VESTOPLAST®

Welcome to the world of **amorphous poly-alpha-olefins**

VESTOPLAST®



VESTOPLAST® grades are amorphous poly-alpha-olefins, produced with three monomers - ethylene, propylene and butene-1. It is mainly used as a raw material for hot melt adhesives that are applied within several industries like hygiene, automotive, packaging and woodworking.

All VESTOPLAST® grades are produced to specification in a continuous Ziegler low-pressure polymerization process. We design polymers with optimum and balanced values for ad- and cohesion, soft- and hardness, open and setting times. Our focus is producing easy to process polymers that offer as well the right melt viscosity, excellent stability and high thermal stabilities under loads.

With more than 40 years of experience, it is our goal to always find the right solution for you!

VESTOPLAST® SPECIAL PROPERTIES AT A GLANCE

- **Good adhesion on various substrates**
- **Excellent cohesion and high green strength**
- **Low carbon footprint**
- **Easy to Formulate:**
  - High or low polymer contents
  - Good compatibility with various additives
  - Adjustable open times
- **Easy to process:**
  - Small Granules
  - High viscosity stability under heat
  - No odor
  - light color
- **Easy to apply:**
  - Vast variety of application methods
  - Low application temperature possible
  - Good color stability
- **Cost efficient – good performance / cost ratio:**
  - Low density, 10% more mileage
  - Excellent Foamability
  - Less maintenance due to self-cleaning effect

No residues currently considered as harmful i.e. no solvents, no aromatics

VESTOPLAST®

The world of amorphous poly-alpha-olefins

"For us, doing business sustainably is not optional. It is the only way to go forward to improve life, today and tomorrow."

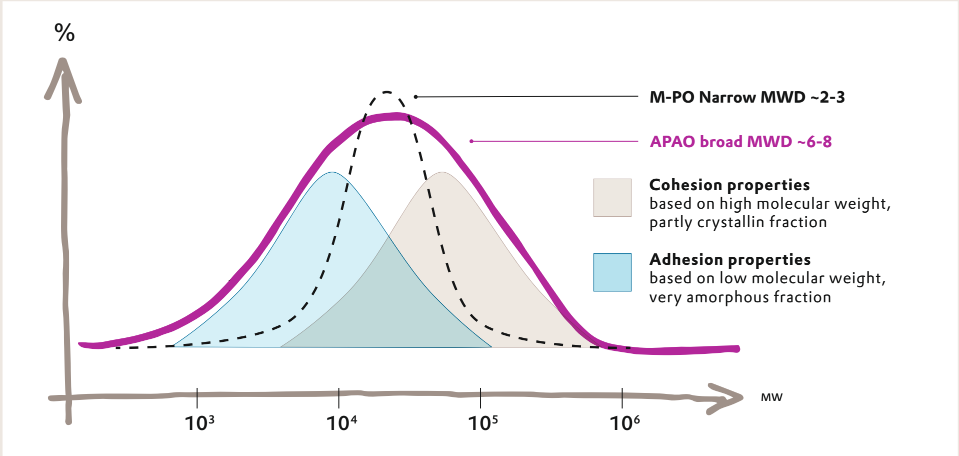
CHEMICAL COMPOSITION

Our manufacturing process and our selection of monomers enables us to produce predominantly amorphous, soft grades but also harder, partially crystalline grades. The chemical structure of VESTOPLAST® ensures compatibility between all VESTOPLAST grades and with various raw materials predominantly used in hot melt formulations (e.g. tackifier, polyisbutylene, isotactic PP).

One decisive advantage of our Ziegler-Natta technology is that VESTOPLAST® polymers offer a broad molecular weight distribution resulting in polymers with an excellent balance of adhesion and cohesion properties.
The low molecular weight fraction shows intrinsic tackifier properties, good wetting and provides adhesive properties. This results in high tackiness and hot tack properties of the polymer itself, compared to other olefinic polymers, thus reducing the need to use additional tackifiers in a hot melt formulation. The high molecular weight fraction and the crystalline moieties provide cohesion and robustness as well as a good compatibility with many polyolefinic substrates.
All VESTOPLAST® grades are free of polar groups, except for VESTOPLAST® 308, which is functionalized.

The VESTOPLAST® backbone is chemically inert, unsaponifiable, resistant to water, acids, alkalis, reducing agents and UV light. Even though the product is hard to dissolve in polar solvents, the softer grades are soluble or swellable in non-polar solvents such as toluene, xylene, mesitylene and hexane.
VESTOPLAST® 206, a silane-modified grade, exhibits extremely low water vapor permeabilities.

All VESTOPLAST® grades are slightly stabilized. However, additional stabilization is recommended by adding systems like those used for polypropylene.



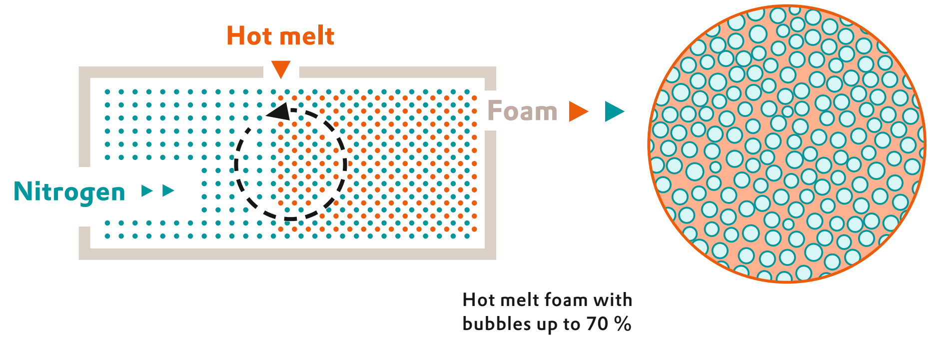
SUSTAINABILITY ASPECTS

Sustainability is a central element for Evonik. We provide innovative solutions that help to make our lives more sustainable, more healthy, and more comfortable.
We, the Coating & Adhesive Resins Business Line, provide products and solutions that reliably adhere and enhance a wide variety of materials, all while contributing to the conservation of resources. Our VESTOPLAST® exhibits a very low carbon footprint compared to other hot melt systems, because of two main aspects:

Low carbon footprint due to polyolefinic nature
The polyolefinic nature of VESTOPLAST® leads to a low carbon footprint due to its early stage production process in the value chain. It is for this reason that VESTOPLAST® has an advantage over systems like styrene-based polymers and polyurethanes and you benefit from a reduced carbon footprint of the raw material.

Low density and corresponding high mileage
The low density of our amorphous polyolefin based hot melts allows for the achievement of high mileage during application. VESTOPLAST® provides even greater benefits because it allows for polymer-rich formulations which requires less modification efforts and thus, you and your customer benefit from a process with a lower carbon footprint.

Resource Efficiency: Foaming of hot melt adhesives
Foamed hot melts have recently been gaining more interest as the industry moves towards more resource and cost-efficient solutions that can maintain, or even improve, performance. Evonik´s VESTOPLAST® offers a raw material to the hot melt industry, which provides the necessary properties for the formulation of foamed adhesives.



DESIGN FOR RECYCLING
Being a thermoplastic polyolefin, VESTOPLAST® is basically ready for the "design for recycling". Heating up beyond the softening point allows for disassembling. Unique possibilities lay in using VESTOPLAST® with polyolefinic substrates like PP in car manufacturing, or in thermoplastic composites with PP fibers.
Staying in one polymer class allows for an easy recycling process since these systems can be collected together, and donot have to be separated. VESTOPLAST®can also be beneficial for recyclates as it can improve impact strength in the polyolefin matrix.

Freedom of formulation

VESTOPLAST® can be formulated with a large number of different polymers, tackifiers and additives. Each ingredient within the hot melt formulation contributes its own characteristic and function to meet the targeted application requirements. Therefore, excellent compatibility with various additives and polymers is a prerequisite to achieve the full range of flexibility. All VESTOPLAST® grades are fully compatible with each other and can be utilized to enhance the performance properties.

Common modifiers in the production of hot melt adhesives

TACKIFIERS

Tackifiers improve adhesion of the hot melt to various substrates and reduce the viscosity. Tackifiers are based on aliphatic or cyclic monomers and may be hydrogenated or unhydrogenated. Due to their molecular similarity, VESTOPLAST® exhibits better compatibility with hydrogenated, aliphatic C5-C9 based tackifiers, rather than with unhydrogenated or cyclic ones. However, APAOs are the only polymer class that exhibits tackiness on its own. Tackifiers will influence the open time of formulations with VESTOPLAST® as well as needle penetration.

EFFECTS

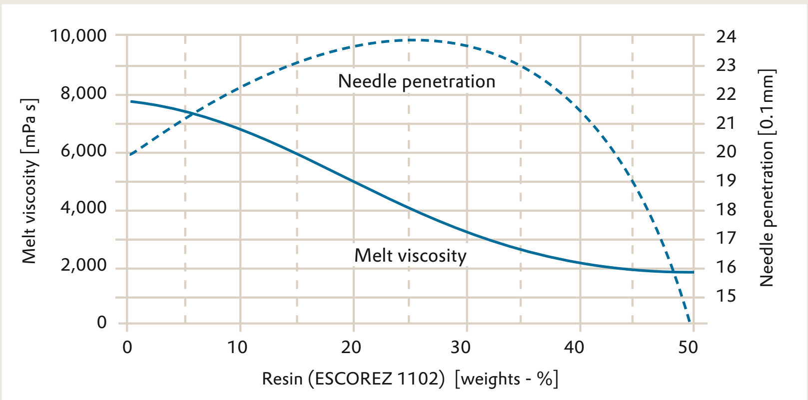
- Reduce melt viscosity
- Decrease cohesion
- Prolong open and setting time
- Increase adhesion
- Increase VOC
- "Softens" the material

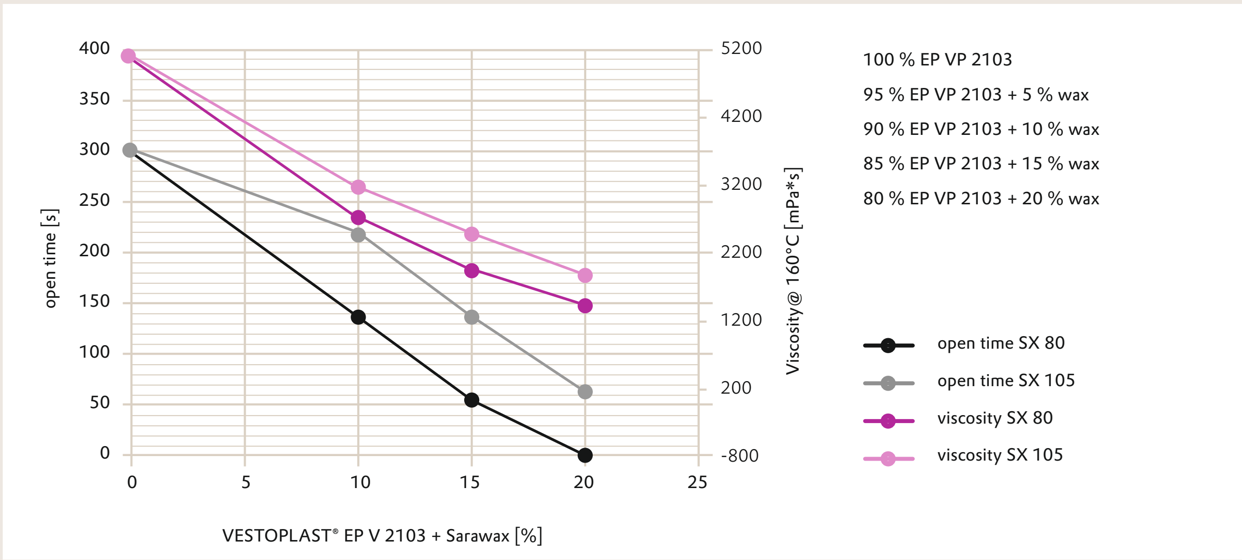
OILS

Oils are mainly used in formulations to reduce the viscosity and to dilute the formulation. Both natural and synthetic oils can be found in the market.
Naphthalenic, paraphenic, hydrogenated or non-hydrogenated oils build up the main base for synthetic oils. They are fully compatible with all VESTOPLAST® grades. However, introduction of oils in VESTOPLAST® formulations can also lead to reduced cohesion and adhesion properties and influence the VOC content.

EFFECTS

- Reduce melt viscosity
- Decrease cohesion
- Prolong open and setting time
- Decrease adhesion
- Act as a Wetting agent





WAXES

In addition to tackifiers, waxes are important modifiers for hot melt adhesive formulations. Depending on the identity of the wax being used and the desired property profile of the formulation, the share of wax in the formulation is 5 - 20%. To achieve a homogeneous batch, the waxes are dispersed finely at elevated temperatures until the cloud point of the formulation is near the solidification temperature.
In hot melts often non-functionalized hydrocarbon waxes are part of the formulation; polyethylene- and Fischer-Tropsch waxes are the most common types of this polymer class.

Fischer-Tropsch-Waxes
High crystallinity and linear structure are the main characteristics for this group of waxes. Therefore, they exhibit low viscosity as well as high hardness and low surface energy, which makes them particularly suitable in hot melt formulations.
Evonik is an exclusive distribution partner of Shell MDS (Malaysia) offering GTL Sarawax SX 80 and GTL Sarawax SX 105 within our represented area. These high quality Fischer-Tropsch waxes exhibit different dropping points and can be utilized for formulations within a wide range of softening points in various applications. Modified Fischer-Tropsch Waxes for specialty applications are available from Evonik under the brand name of VESTOWAX®.

EFFECTS

Formulation of VESTOPLAST® with waxes will result in:

- Reduced melt viscosity
- Reduced open and setting time
- Reduction of angel hair formation
- Increased hardness and brittleness
- Enhancement of water vapor barrier function
- Reduction of adhesion

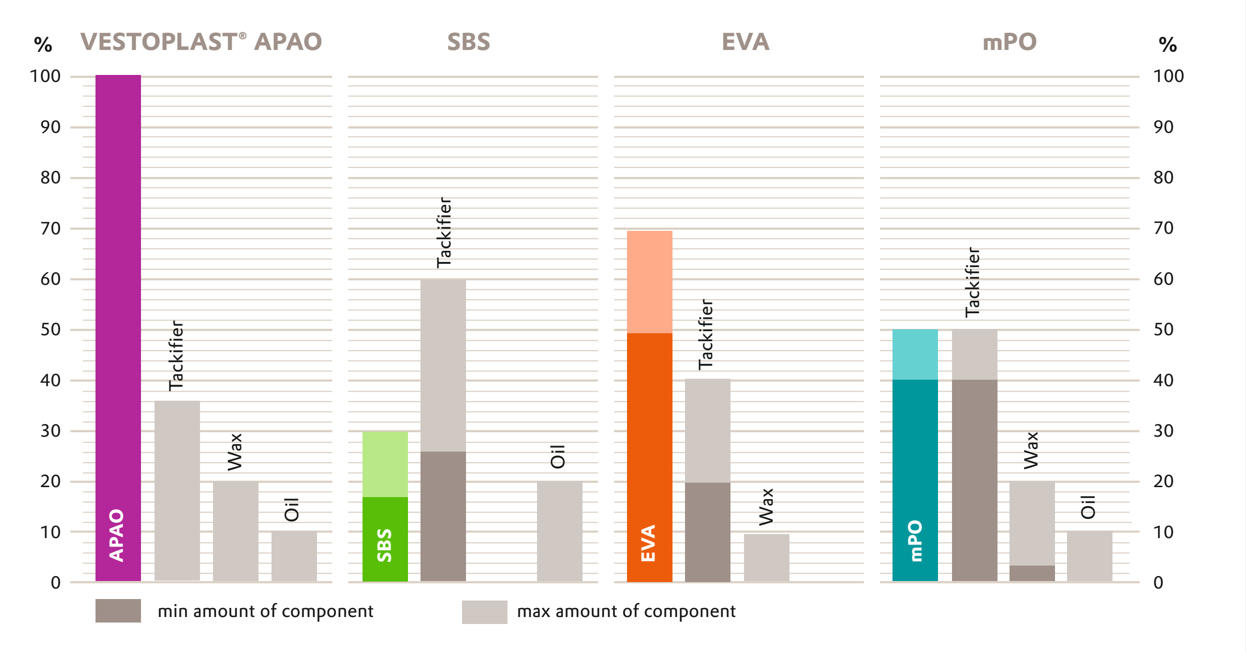
Test results

VESTOPLAST® EP V 2103 out	%	100	90	85	80	100	90	85	80
Sarawax SX 105	%					0	10	15	20
Sarawax SX 80	%	0	10	15	20				
Melt viscosity @ 160°C	[mPas]	5100	2740	1980	1400	5100	3170	2440	1830
Open time	[s]	300	140	55	<2	300	220	140	60

Freedom of formulation

Evonik´s VESTOPLAST® grades all account for the main backbone structure of hot melt adhesive formulations, defining the key properties of the end formulation. All VESTOPLAST® grades have a broad molecular weight distribution, thus resulting in amorphous moieties of lower molecular weight that contribute to adhesion properties, as well as crystalline higher molecular weight moieties that provide cohesion properties.
The high molecular weight components are responsible for high cohesion and inner strength, while the lower molecular share of the molecular weight will determine adhesive properties and improve wetting behavior to various substrates.
Therefore, VESTOPLAST® formulations can be utilized with reduced tackifier content. Since low viscous grades are available, it is possible to formulate high polymer content formulations and in order to reduce VOC/FOG.

Formulation window of various polymers and additives



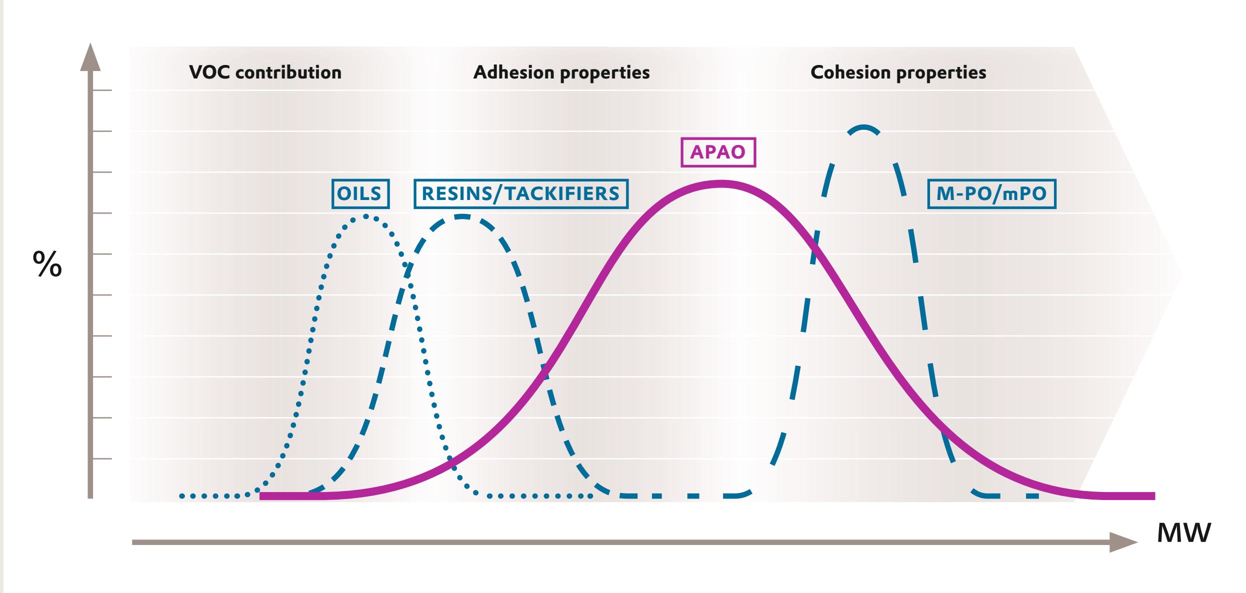
VESTOPLAST® APAO
- Highest polymer content possible, but not necessary
- Low tackifier content possible
- Option to formulate without oil
- Almost no dilution
- High SAFT, determind by polymer

SBS
- Low polymer content
- High tackifier content
- Contains oil
- No wax
- High amount of low molecular weight components
- Polymer is highly diluted

EVA
- Medium polymer content
- Medium tackifier content
- Possible without oil
- Polymer is highly diluted

mPO
- Medium polymer content
- High wax content
- Possible without oil
- Medium amount of low molecular weight components
- SAFT determined by wax
- Polymer is highly diluted

VESTOPLAST® Molecular weight distribution principals



VESTOPLAST® APAOs allow for high polymer content formulations with low additive content. VESTOPLAST® is the only polymer that exhibits adhesion on its own!

VOC

Volatile organic compounds (VOCs) have a high vapor pressure at room temperature, especially oligomers and low molecular weight fractions that are easy to evaporate. These can be critical in odor sensitive applications like the automotive industry. The VOC content can be measured with different methodologies depending on the application and industry. Especially very low molecular weight parts create high VOC values, as it is shown in the figure below. Formulations with high VESTOPLAST® content have a lower VOC content due to less oil, resin and additive consumption.

LOW ODOR – VDA 270

With growing health concerns, customers and end-users are now even more aware of the odor topic and demand final products with less smell or even no smell at all. This trend has already reached different application fields.
Additionally, regulations are pushing for more transparency and setting restrictive standards for raw materials and final products.

Test results*

VESTOPLAST® grade	EP V2094	EP V2094	703	703	750	750
Test temperatur	23°C	40°C	23°C	40°C	23°C	40°C
Grade	1	1,5	1	1,5	1	1,5

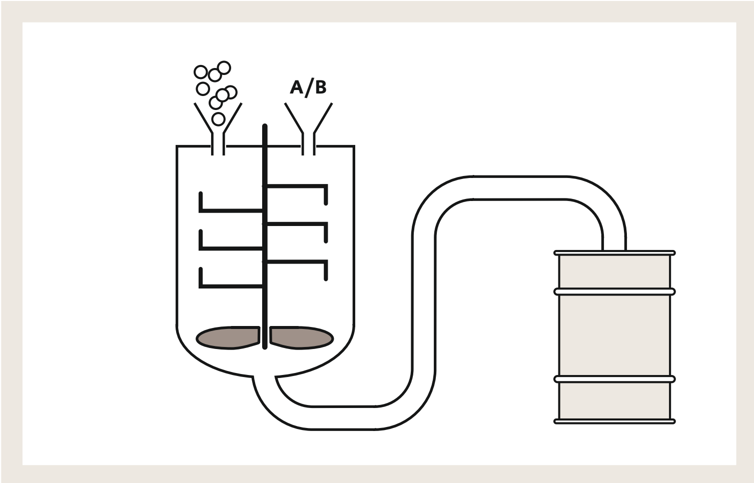
*VDA 270: measured by Fresenius Institut

Processing

VESTOPLAST® granules can be processed with different types of standard equipment.*

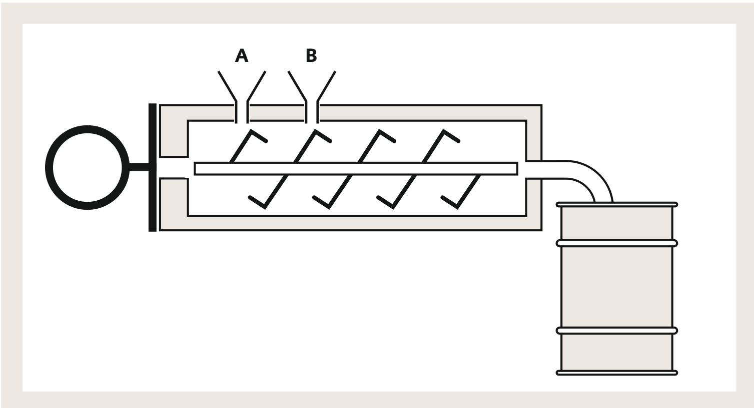
STIRRING TANK REACTOR

Granules can be charged and melted easily inside a tank reactor. The additon of additives and production of a homogeneous melt can be achieved in this batch process.



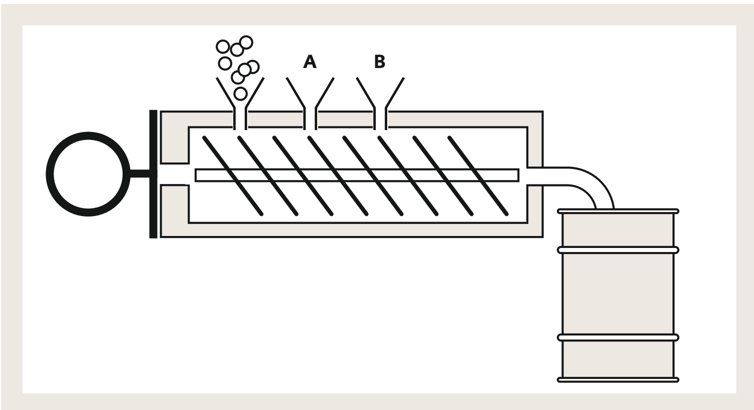
KNEADER

Batch processes inside a kneader promote high shear forces for the combination of VESTOPLAST® with rubber. This process is often used to produce high elastic or pressure sensitive products.



EXTRUSION

Extrusion is a continuous process that allows melting, additive charging and degassing in a one step process. The unique delivery in small granules makes charging into an extruder both easy and facilitates processing inside the screw.



*For more information regarding product & processing compatibility please contact us.

Application methods

With VESTOPLAST® based formulations there is an extensive possibility for various application technologies. Due to the wide range of VESTOPLAST® types and their shear thinning behavior, they can be applied in several ways.

Bead application

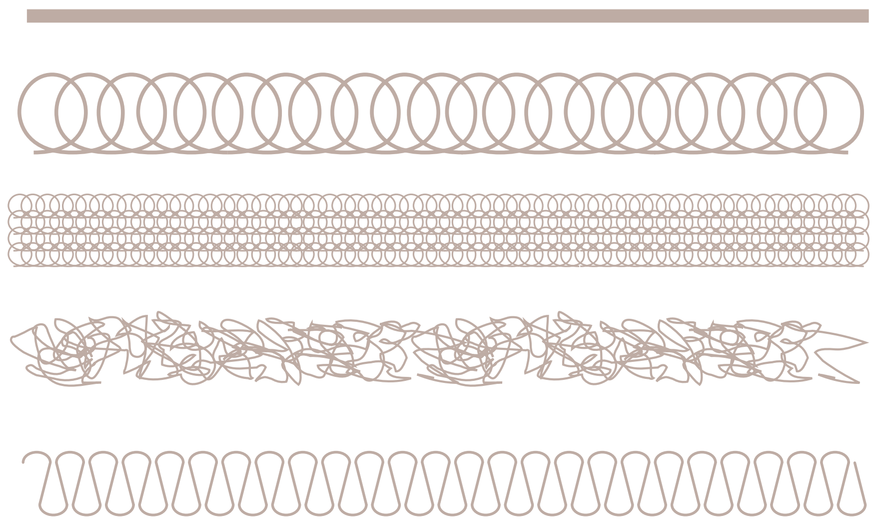
Line

Spiral Spray

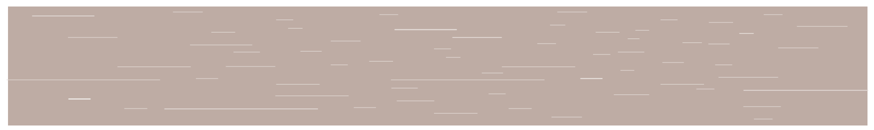
Summit

Signature

Omega

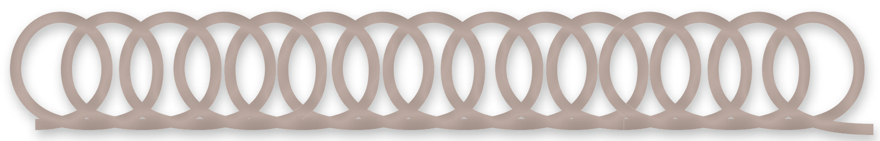


Slot application



Intermittent application

Foam application (bead/spray)



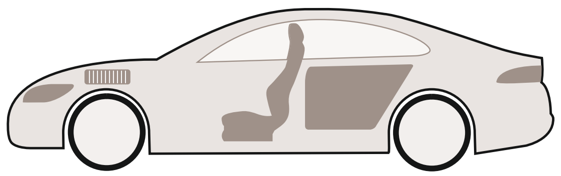
Areas of application

All VESTOPLAST® grades are characterized by the following product properties and show great performance in different applications.

- **Easy to melt and formulate**
- **High thermal stability: color stability, no viscosity drop, low cracking**
- **High initial green strength**
- **Low odor, white color**
- **Low density for high yield and mileage**
- **High polymer content formulations possible, low dependence on tackifiers**

Furthermore, our portfolio contains unique grades, ideally suited for the special requirements of your industry or application field.

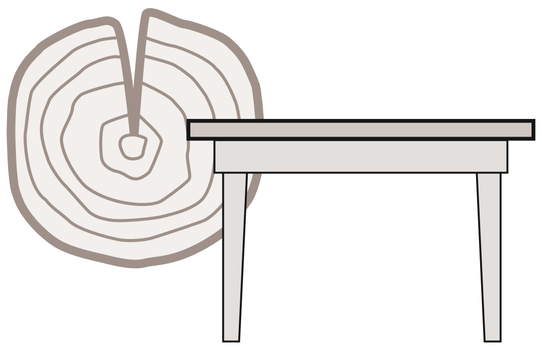
AUTOMOTIVE



APPLICATION AREAS
- Interior lamination
- Felt bonding
- Car carpets and mats
- Air filter
- Batteries

SPECIALTY PROPERTIES
- High softening point and heat stability (SAFT)
- Adhesion to various substrates, especially PP without pretreatment
- Chemically inert, water and UV-resistant

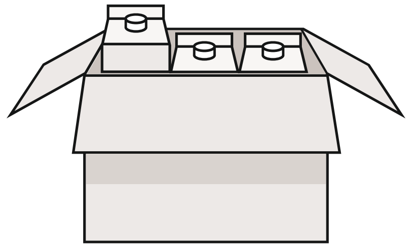
WOOD WORKING



APPLICATION AREAS
- Banding
- Profile wrapping

SPECIALTY PROPERTIES
- High softening point and heat stability (SAFT)
- Adhesion to various substrates, especially PP without pretreatment
- Chemically inert, water and UV-resistant

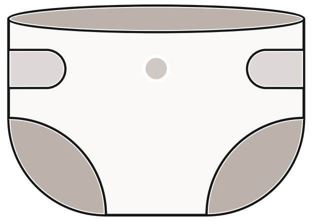
PACKAGING



APPLICATION AREAS
- Hot filling
- Straw attachment
- Special applications

SPECIALTY PROPERTIES
- Excellent bonding on coated paper, PP and PE
- Compatibility with FT hard waxes for fast setting

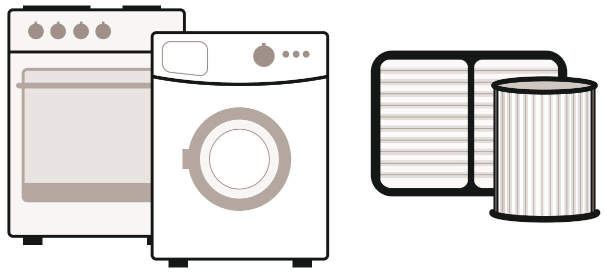
HYGIENE



APPLICATION AREAS
- Diaper assembly
- Back-sheet lamination
- Medical applications

SPECIALTY PROPERTIES
- Wide application window
- Excellent sprayability down to 120°C for spiral spray
- Spray and slot application possible
- Low application weight

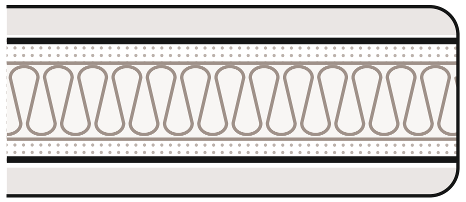
ASSEMBLY



APPLICATION AREAS
- **White goods**
- **Air filter**

SPECIALTY PROPERTIES
- Variable open time due to a broad spectrum of formulations with tackifier and waxes
- Application as foamed spray or glue line possible

MATTRESSES



APPLICATION AREAS
- **Lamination**
- **Construction or pocket coil**

SPECIALTY PROPERTIES
- Solvent and water free
- Fast processing
- Variable in setting and open time for machine and hand application
- Low application temperature possible

VESTOPLAST®

Product Portfolio

Product Range

Properties	Melt Viscosity at 190° [mPa s]	Softening Point (Ring & Ball) [°C]	Needle Penetration (100/25/5) [0.1 mm]	Thermal Stability under Load S.A.F.T. [°C]	Tensile Strength/ Elongation at Break [MPa/%]	Shear Modulus at 23 °C [MPa]	Molecular Weight M_n / M_w [g/mol]	Open Time [s] resp. [min]	Glass Transition Temperature Tg DSC analysis [°C]	Density at 23 °C [g/cm^3]	Shore Hardness A
(1-) Butene-rich											
308	8,000 ± 2,000	136 ± 6	17 ± 3	65 – 70	1.5 / 500	14	11,300 / 49,000	4	-29	0.87	n.d.
408	8,000 ± 2,000	118 ± 4	5 ± 2	85 – 90	6.8 / 80	70	11,600 / 48,000	65 s	-27	0.90	94
508	8,000 ± 2,000	84 ± 4	14 ± 3	60 – 65	1.5 / 340	12	11,800 / 52,000	15	-31	0.87	74
520	22,000 ± 4,000	87 ± 4	14 ± 3	65 – 70	2.4 / 80	7	13,900 / 63,000	15	-29	0.88	76
608	9,000 ± 3,000	157 ± 4	18 ± 3	60 – 65	1.5 / 480	11	12,300 / 46,000	3	-32	0.87	76
EP V2103*	2,500 ± 500	103 ± 3	12 ± 3	90 – 95	2.0 / 40	n.d.	8,500 / 50,000	~ 5	-33	0.86	n.d.
EP V2094*	2,500 ± 500	94 ± 4	20 ± 4	80 – 85	1.0 / 70	n.d.	9,000 / 55,000	> 10	-38	0.86	n.d.
Propene-rich											
703	2,700 ± 700	124 ± 6	12 ± 3	75 – 80	2.1 / 43	41	7,300 / 34,000	15 s	-28	0.87	87
704	3,500 ± 500	105 ± 5	23 ± 5	70 – 75	0.5 / 100	7.5	8,000 / 35,000	80 s	-36	0.87	n.d.
708	8,000 ± 2,000	106 ± 4	19 ± 3	85 – 90	1.0 / 330	4	11,500 / 75,000	55 s	-33	0.87	67
750	50,000 ± 10,000	107 ± 4	14 ± 3	85 – 90	5.0 / 1,000	14	18,100 / 92,000	50 s	-33	0.87	75
751	50,000 ± 10,000	99 ± 4	25 ± 3	60 – 65	1.5 / 1,000	2	18,800 / 88,000	30	-33	0.87	43
792	120,000 ± 30,000	108 ± 4	14 ± 3	90 – 95	5.8 / 1,200	7	23,800 / 118,000	2	-27	0.87	n.d.
828	25,000 ± 7,000	161 ± 4	22 ± 3	95 – 100	1.0 / 550	4	13,200 / 61,000	70 s	-35	0.87	n.d.
888	120,000 ± 40,000	161 ± 5	16 ± 4	115 – 120	2.5 / 850	6.5	15,000 / 104,000	4 s	-36	0.87	n.d.
891	115,000 ± 35,000	162 ± 4	22 ± 4	105 – 110	2.0 / 1,000	3	18,800 / 85,000	40 s	-33	0.86	n.d.
EP 807*	7,000 ± 2,000	161 ± 3	7 ± 3	125 – 130	4.0 / 40	n.d.	n.d.	< 2 s	n.d.	n.d.	n.d.
Silane modified											
206	5,000 ± 1,000	98 ± 4	19 ± 3	> 160[1]	1.9 / 720	n.d.	10,600 / 38,000	~ 20 s	-28	0.87	n.d.

* Experimental Product [1] after curing n.d. = not determined

VESTOPLAST® 206

Reactive silane modified specialties

A special grade for special applications

VESTOPLAST® 206 is a reactive adhesive raw material based on a silane grafted polymer which is moisture curing and has a unique amorphous poly-alpha-olefin backbone structure. It is characterized by its excellent adhesion to a very wide range of plastics (e.g. polypropylene, polyester and polyamide), to wood and 'hard-to-adhere-to' polar substrates like glass, ceramics and metals.

Improved adhesion properties due to polymer crosslinking

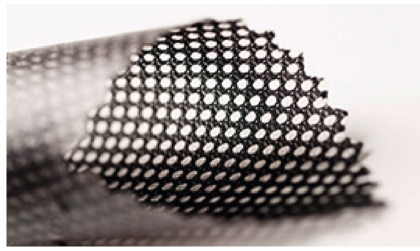
The silane groups are grafted to the VESTOPLAST® backbone and can crosslink in the presence of humidity by eliminating an alcohol. The polyolefin backbone provides initial bonding strength and setting until the final curing process is finished. The reaction can be accelerated by adding a catalyst.

WINDOW GLAZING

- Primary sealing of multi-glazed windows
- Excellent adhesion to glass and/or metal

AUTOMOTIVE

- Bonding on PP without pre-treatment
- Substitution of PUR systems
- Interior bonding



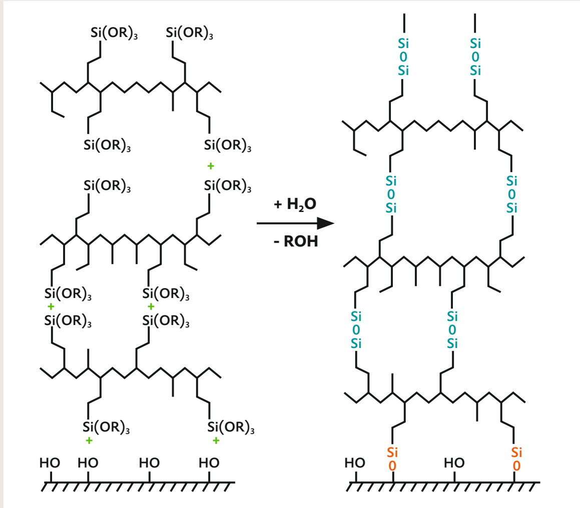
COMPOSITES

- Glassfiber composites
- Sandwich panels
- Lightweigth manufacturing

Formulation recommendation

- Can be used as a 100 % system
- Can be formulated like any other (non-reactive) VESTOPLAST® grade with resins, oils, waxes, polymers and additives
- Recommended in formulation with minimum amount of 50% or pure

Crosslinking Reaction



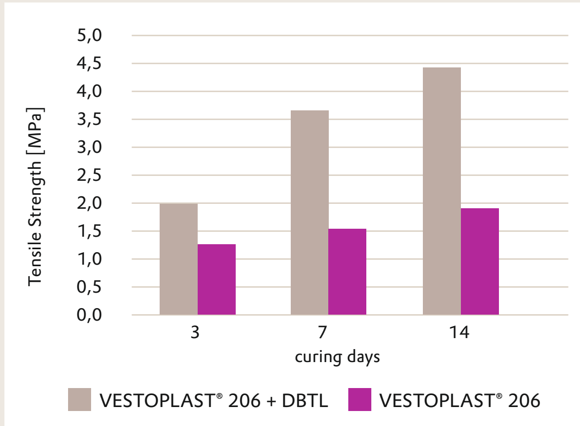
PROPERTIES

- Melt viscosity (190 °C): 3.000 – 12.000 mPa.s
- Softening Point (R & B): 91 – 100 °C
- Needle Penetration: 15 – 22 0,1mm
- Open Time: 20 – 60 sec

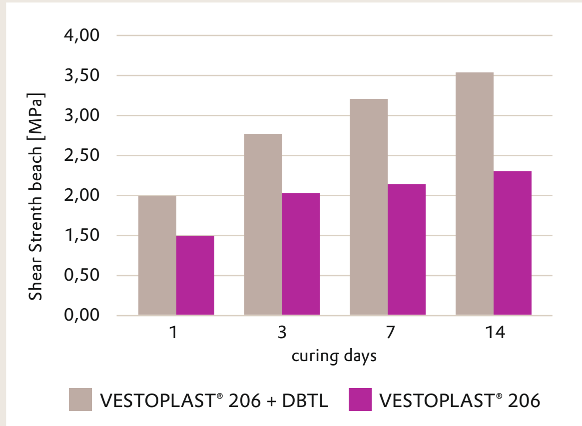
BENIFITS

- Very high thermal stability (S.A.F.T.) under load
- Improved adhesion to various substrates, e.g. untreated PP
- Extreme flexibility after curing
- Fast setting due to VESTOPLAST® backbone
- Isocyanate free
- Reactive system based on silane groups

Tensile Strength VESTOPLAST® 206



Shear Strength beach VESTOPLAST® 206



The curing process can be monitored through increasing tensile and shear strength values. A catalyst (e.g. tin free catalysts or DBTL) can accelerate the process

Analytical methods

• Melt Viscosity
Determination according to DIN 53 019, modified. The melt viscosity is determined by a rotational viscosimeter. It describes the melting flow behaviour at 190 °C: high viscous grades exhibit a slight dependence on shear rate, low viscous grades are almost newtonian at elevated tempertaures.

• Softening Point (Ring & Ball)
Determination according to DIN EN 1427. The material is heated up at 180 °C and then the melt is casted into a ring. After 24 h (this time is needed for recrystallization of the amorphous products) the sample is stressed concentrically with a chrome-plated steel ball and the test frame is immersed in a bath of glycerin. This is heated up at a rate of approx. 5 °C/min. The softening point is the temperature when the ball contacts the baseplate of the test frame.

• Needle Penetration
Determination according to DIN EN 1426, modified. The material is heated up at 180 °C in a tin can. After 24 h (this time is needed for recrystallization of the amorphous products) the hardness of the product is determined with a needle and weight of 100 g at 25 °C. The penetration time into the sample is 5 s.

• Thermal Stability under Load / S.A.F.T.
Determination according to an Evonik method, similar to WPS 68. The thermal stability under load describes the thermal stability behavior of bonded substrates. In case of VESTOPLAST®, we use grey board to compare each VESTOPLAST® grade with one another. A drop of the melt (180 °C) is placed on one side of the board and is pressed to another grey board (T-form). After 24 h the prepared specimens is placed in a heating cabinet with a weight of 450 g and heated up at a rate of 5 °C/h. The thermal stability is the temperature at which the bonded specimen breaks down.

• Tensile Strength / Elongation at Break
Determination according to DIN EN ISO 527-3, modified type 5. The tensile strength describes the tensile and elongation properties of a specimen type 3 with a 2 mm thickness.

• Shear Modulus at 23 °C
Determination according to DIN EN ISO 6721-2.

• Molecular Weight Mn/Mw
Determination according to GPC, DIN 55 672, modified. The molecular weight is calculated according to GPC, DIN 55672-1, detailed in Mn and Mw.

• Open Time
Determination according to an Evonik internal method. The melt (180 °C) is applied as a film of 20 µm on a paper. Strips of paper are pressed into the film at certain intervals (depending on the open time). 30 minutes after the last strip has been applied, a test is carried out to see which of the last strips applied can be lifted off without pulling out the paper fibers. The time at which this strip was applied is noted.

• Glass Transition Temperature
Determination according to DIN 53 765.

• Density at 23 °C
Determination according to DIN EN ISO 1183-1.

• Shore Hardness A
Determination according to GPC, DIN 53 505. This determination specifies the hardness of a specimen , which measures the resistance against penetration of a specific form and specific spring tension. The values are dependant on the visco-elastic properties of the polymer.

General information & product safety

General Information

- Poly-alpha-olefin based VESTOPLAST® is a non-hazardous material and is therefore not labelled according to GHS regulations. For details see safety data sheet, upon request.
- VESTOPLAST® does comply with various food contact regulations, e.g. in the US, Europe, Japan and China. For details consult the respective product safety information sheet.
- VESTOPLAST® does comply with REACH regulations and is listed on or is compliance with many chemical inventories.
- VESTOPLAST® does comply with many additional regulations. Documents will be provided upon request.

Supply Form VESTOPLAST®
VESTOPLAST® is supplied as granules in 20 kg polyethylene bags on CP4 palettes. A special wax powdering is used to improve the flowability of the product.

Supply Form VESTOPLAST® 206
160 kg in 200 l drums, 10 kg easy peel packages

VESTOPLAST® base monomers are: Ethene, Propene, Utene

Non of the substances is used for the production of VESTOPLAST®: e.g. Benzene, Toluene, Ethylbenzene, Xylene, Styrene, Formaldehyde, Acetaldehyde, Acroleine

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