ALBERDINGK BOLEY

Technology Information

ALBODUR®

Castor oil based polyols

ALBERDINGK BOLEY

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ALBERDINGK BOLEY in a nutshell

 Leading international manufacturer of environmentally friendly water-based binders and oils with unique properties to refine, refurbish, bind and protect multiple types of substrates	 Medium sized, privately owned company > 250 million Euro group turnover in 2021 > a partner to our customers for 250 years	 > 500 employees
 Dynamic, Innovative and flexible Pioneers in biobased polymer dispersions	 Dispersions: Acrylic, Vinyl acetate, Polyurethane and hybrid dispersions Oils: Linseed oil, Castor oil, Derivatives	 Locations: • Krefeld, Germany • Kerpen, Germany • Leuna, Germany • Treviso, Italy • Greensboro, USA • Shenzhen, China • Zhuhai, China

For more information about ALBERDINGK BOLEY and our product offerings, visit www.alberdingk-boley.de.

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Key facts about ALBODUR®

Full range of 100% solid polyols for various application fields

- **Green Product Based on castor oil ➔ renewable resources**
- Branched polyether-polyester polyols
- Adjustable from soft-elastic to hard properties
- Very low viscosity, very hydrophobic nature
- Easy to formulate / high pigment-filler loading
- Crosslinkable with aromatic & aliphatic polyisocyanate
- No VOC – absolutely solvent-free
- Economically attractive

General Applications

Floorings (MDI-based)

Coatings (HDI-based)

Elastomers/ Sealants

Corrosion Protection

Potting resin

Adhesives 1- and 2-pack

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ALBODUR® portfolio overview

ALBODUR®-product	Viscosity [mPas]	OH-value [mg KOH/g]	Shore A	Shore D	Features
ALBODUR® 102	700	89	n.a.	n.a.	Reactive diluent
ALBODUR® 110	300	62	n.a.	n.a.	Reactive diluent
ALBODUR® 901	600	185	75	25	Flexible systems
ALBODUR® 903	600	160	62	15	Medium flexible
ALBODUR® 912	600	208	93	44	Medium hard but flexible
ALBODUR® 916	2,200	160	96	59	Low viscosity standard quality
ALBODUR® 917	3,000	165	98	65	Standard medium hard quality
ALBODUR® 918	3,500	164	98	65	Standard medium hard quality long pot life
ALBODUR® 921	600	218	97	60	Hard but flexible
ALBODUR® 923	3,000	234	99	75	Hard polyol, less moisture sensitive
ALBODUR® 924	2,500	232	98	65	Hard flexible low conductive polyol
ALBODUR® 942	500	318	99	80	Very hard (epoxy-like) polyol with longer pot life
ALBODUR® 956	2,600	280	95	55	Hard aliphatic-curable
ALBODUR® 965	1,100	291	93	45	Soft aliphatic-curable
ALBODUR® 1054	2,900	210	80	30	UV stable polyol

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Why is castor oil the perfect base for polyols?

Castor oils are the only OH functional natural oils which can be used in polyurethane systems. The oil characteristics offer polyurethane systems a natural hydrophobicity and supports isolation properties as well as fire resistance.

Unlike other oils, castor oil viscosity is strongly dependent on temperature.

The lowest viscosity can be achieved at 40°C, therefore castor oil is ideally delivered between 30 and 40°C. That provides easy handling, low energy consumption on pumping, high pigment loading etc.

ALBERDINGK BOLEY offers various kinds of castor oil derivatives and polyols based on castor oil.

Additional to refined castor oil FSG (First Special Grade castor oil also called first press) other castor oil qualities can be used for the production of polyols but also to reduce viscosity or enhance flexibility.

ALBERDINGK® Product	Properties / Descriptions	Application fields
Castor Oil FSG/ No. 1	standard quality	typical PU applications (see above)
Pharmaceutical Castor Oil Qualities	lowest colour and acid value, free from any technical contaminations	especially for sensitive applications with a high demand for the purity and / or colour, e. g. medical equipment
Castor Oil Low Acid	technical oil with a low acid value	especially 2-pack systems which require a long pot live time (e. g. adhesives), applications under high temperature, less side reactions with water

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Low Moisture Oil Product	Properties / Descriptions	Application fields
Albodry Castor Oil PU Quality	water reduced standard quality (water content max. 0.05%)	typical PU applications
Albodry Low Moisture 1500 Castor Oil	utilized for applications which prohibit the use of molecular sieve, e.g. transparent systems.	typical PU applications

Chemically modified Products	Properties/ Description	Application fields
ALBERDINGK® Castor Oil PD	partially dehydrated, lower hydroxyl value and lower functionality	especially for soft and flexible PU resins
ALBERDINGK® Blown Castor Oil	oxidatively polymerized Castor oil	cross-linking component, increases hardness and hydrolysis stability

Impact factors on 2-pack systems

Isocyanate vs. polyol properties

In two component applications, both components have equal impact on the properties of the system. That's why the choice of Polyol is as important as the choice of isocyanate. Additionally, additives like catalysts in aliphatic systems have a strong impact on the development of the system properties as well as on yellowing or syneresis while curing.

Because of the unique chemistry of castor oil, unlike other chemical structures, the glass transition temperature (Tg) does not give a clear hint about the performance of the material like drying speed and hardness.

The following chart shows the performance of **ALBODUR®** in combination with different polyisocyanates.

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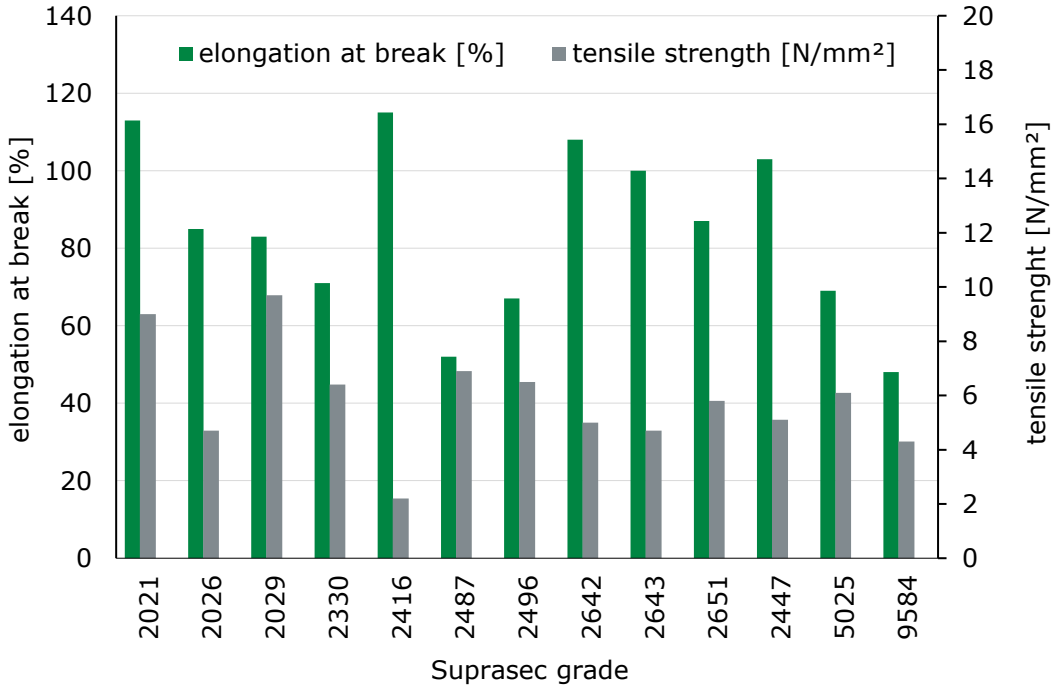
Impact of different Isocyanates on the mechanical properties



Blending of isocyanate and polyols

Castor oil and MDI normally are very compatible and can be homogenized easily. With increasing molecular weight and/or OH value of the polyol, compatibility becomes more difficult. That's why blending time and methods are very important depending on types of polyols and isocyanates.

Additionally, the polyol/isocyanate-reaction is very slow in comparison to isocyanate/water-reaction. The more isocyanate is used, the higher the tendency for faster reactions with moisture.

In elastomer applications premix equipment is used to achieve excellent homogenization. This leads to better surface quality and less surface-defects in comparison with manual mixing equipment.

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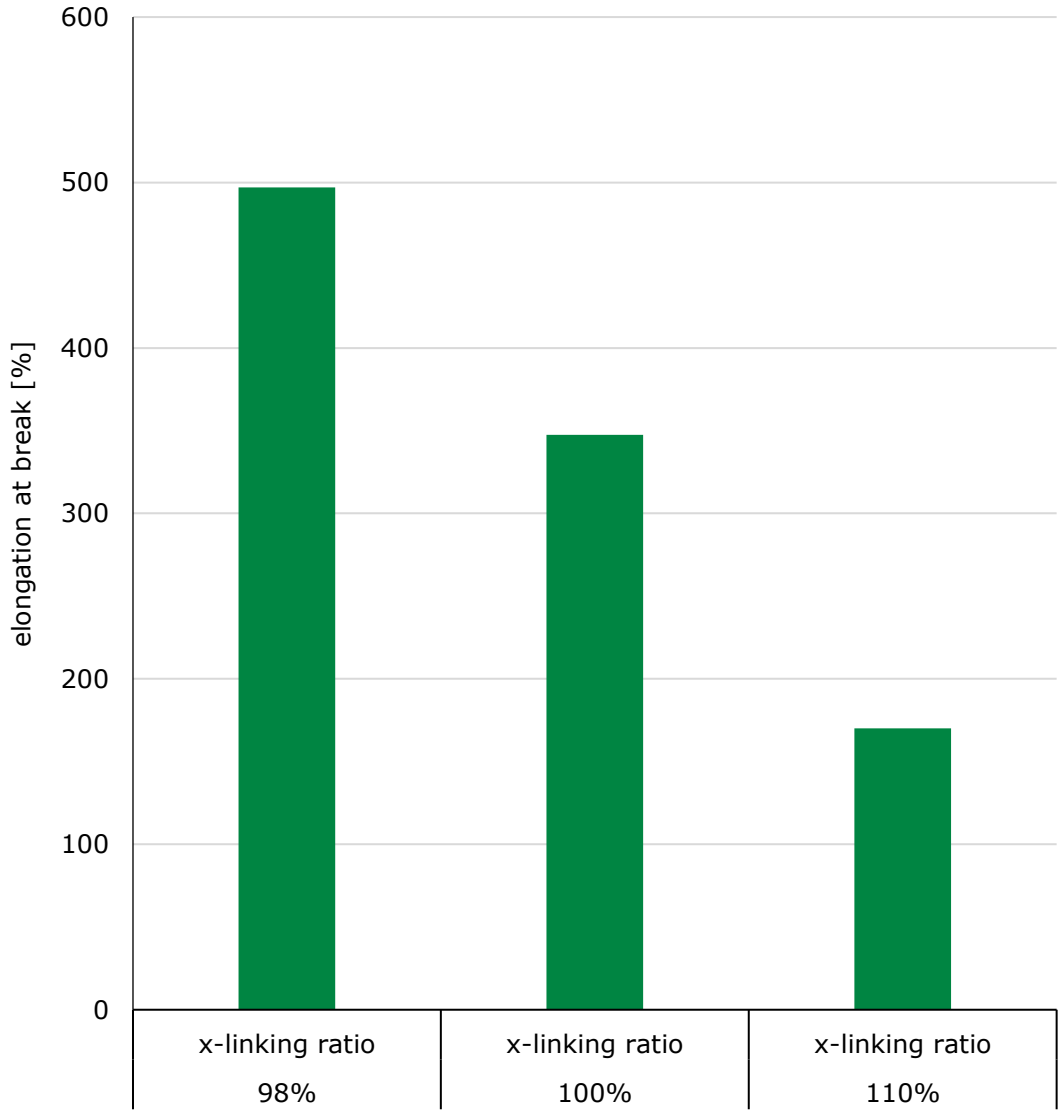
Crosslinking ratio

Secondly, the crosslinking ratio between polyol and isocyanate can be an additional adjustment. In order to provide higher application security, a slightly over-crosslinked system is used. For membranes, waterproofing or crack bringing application, a lower amount of isocyanate can adjust the flexibility.

Mechnical properties of ALBODUR® + Suprasec® 2021

(after 2d RT + 3d @ 50°C)



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Impact of moisture

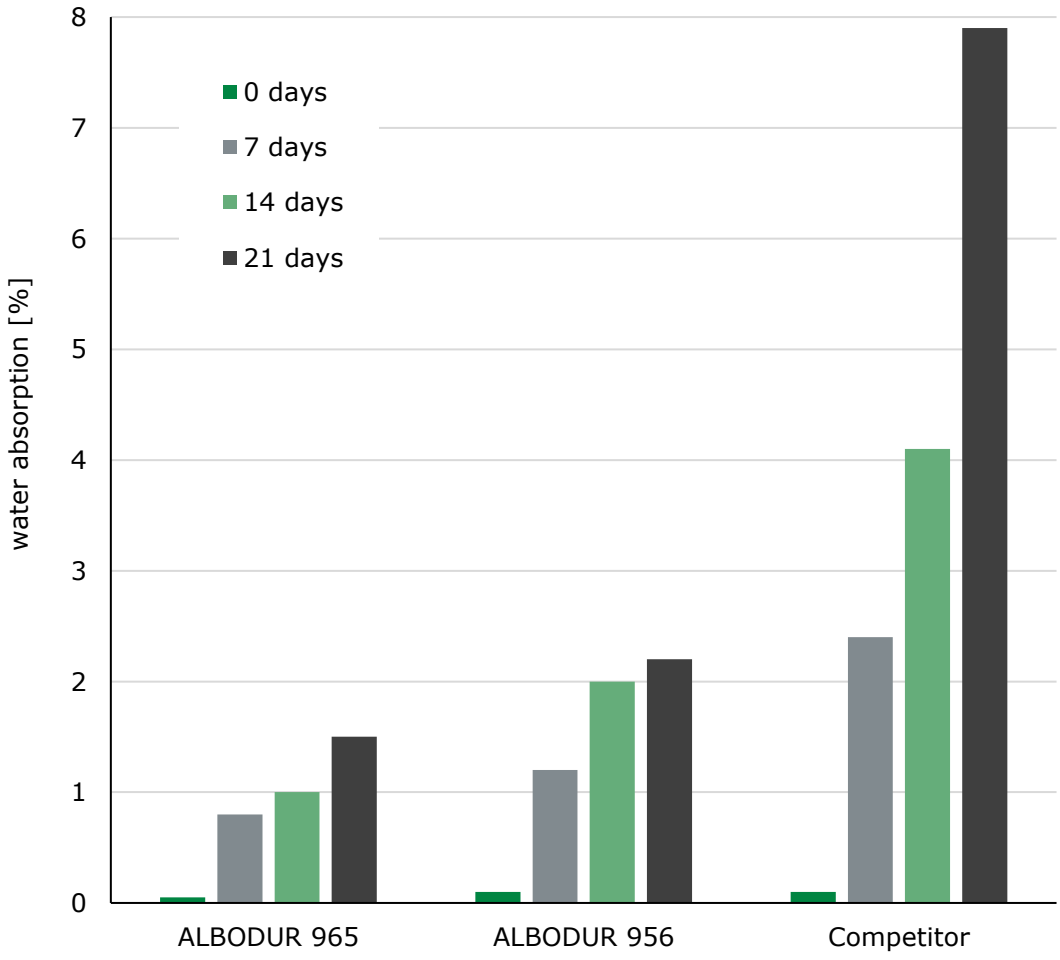
Water absorption of **ALBODUR®**

Water has a much faster reaction with the isocyanate than with castor oil based polyols. Therefore in high film thickness applications it is important to reduce the amount of water with moisture scavengers like molecular sieves or oxazolidines. **ALBODUR®**-products have a very low affinity to water and a low water absorption tendency in storage, compared to standard technologies.

Due to the compatibility of water with castor oils, water cannot be optically observed like in other oils.

That's why it is very important to store the material under the recommended conditions.

Applications which use aliphatic hardeners are even more critical to moisture than aromatics.



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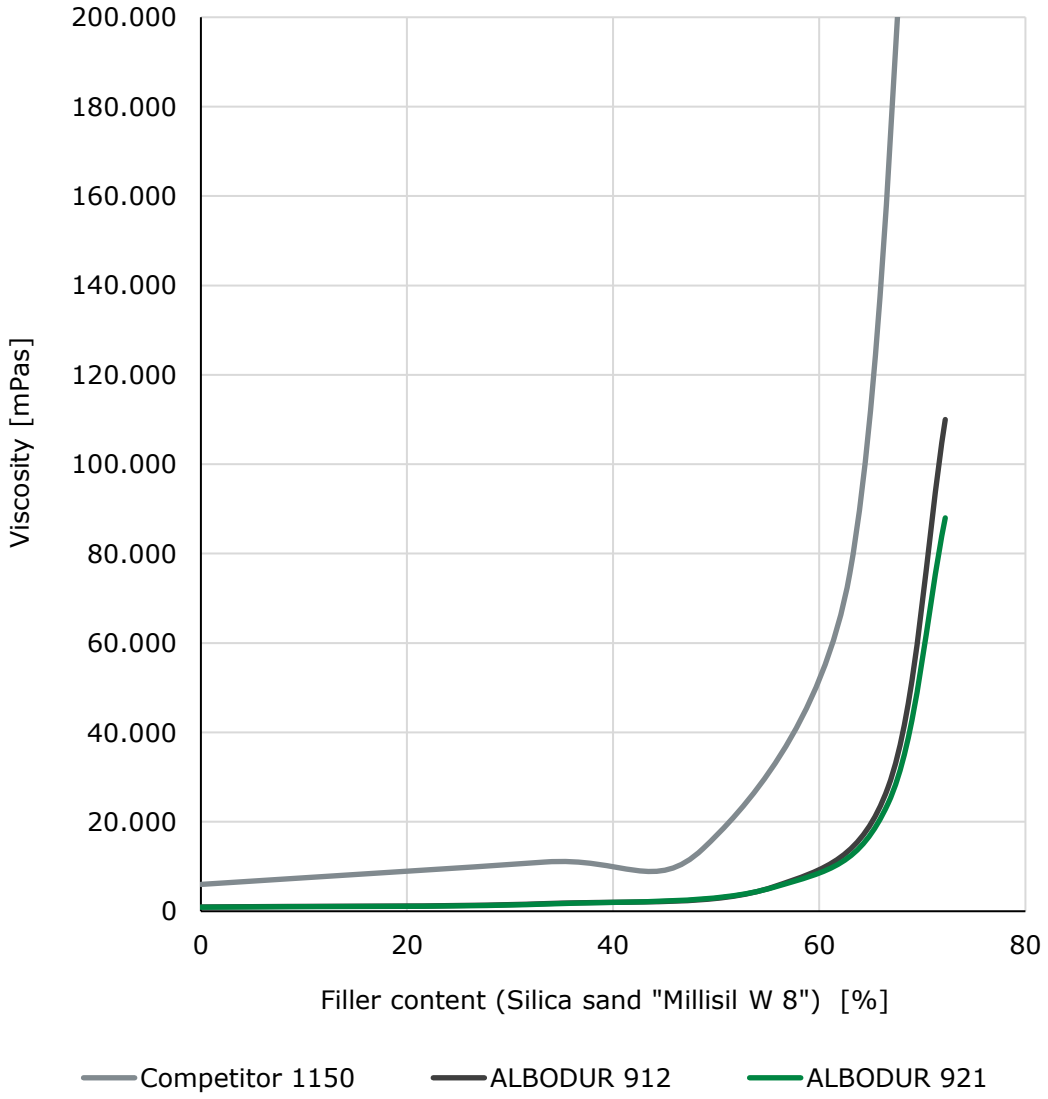
Impact of polyol viscosity and pigment wetting properties

ALBODUR®-polyols have a lower viscosity and a higher hydrophobicity compared to market standard polyols. This leads to high pigment / filler loading and reduces formulation cost.

ALBODUR® 921 can be formulated with 20% more filler silica sand than Competitor 1150. This can be even increased by wetting and dispersing additives.

The high hydrophobicity leads to low stabilisation of foam and the shear thinning behaviour of the polyol supports the self-levelling properties. Hardness and elasticity development are similar to Competitor 1150.



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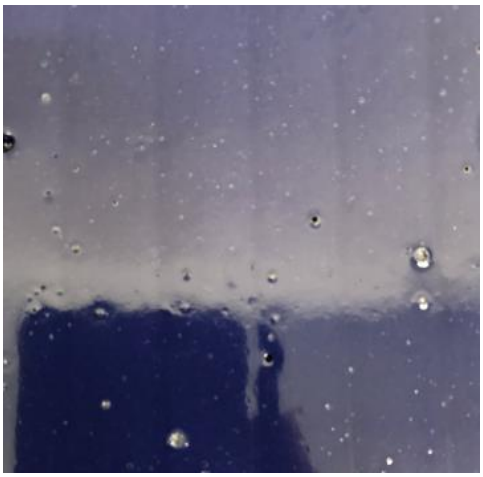
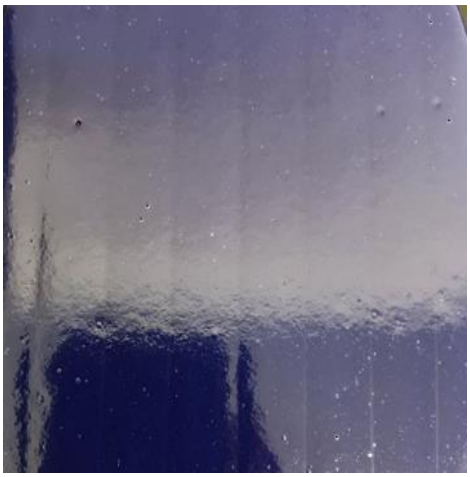
Comparison of 20% Polyol | 80% Calcium carbonate | no additives

Comparison foam and levelling:

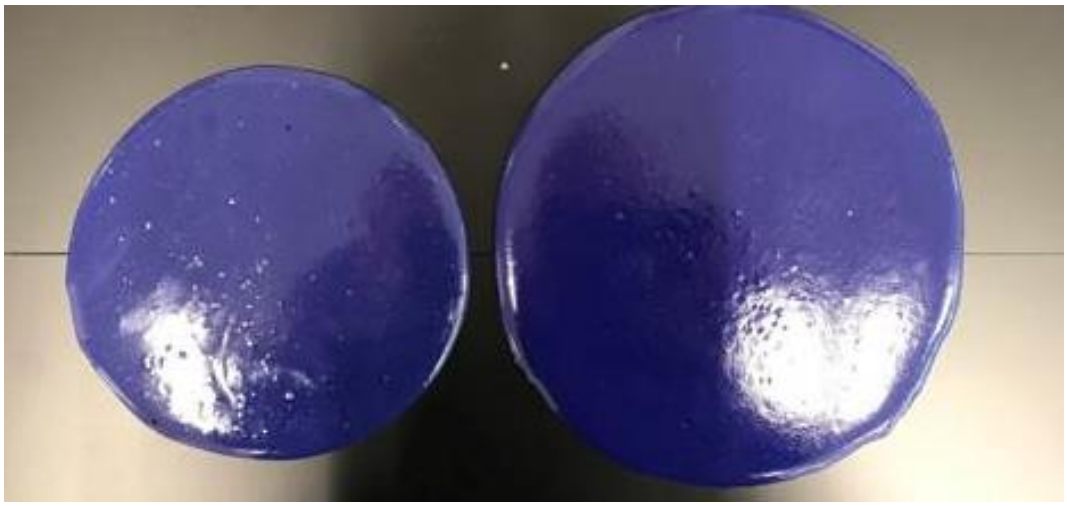


Competitor 1150



ALBODUR® 921

Comparison self-levelling properties:



Competitor 1150

ALBODUR® 921

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Applications for ALBODUR®

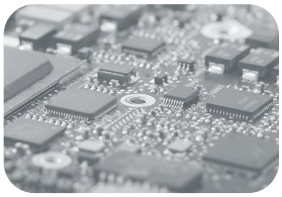
Polyol based floor coatings

Floorings (MDI-based)

Coatings (HDI-based)

Elastomers/ Sealants

Corrosion Protection



Potting resin

Adhesives 1- and 2pack

In the past, floor coatings were mainly applied in industrial areas thanks to their high chemical and physical as well as mechanical resistance. Within the recent years, the focus of the major requirements for the floor coating market has changed.

Floor coatings are getting more attention in residential areas for decorative purposes or in hospitals due to their high hygienic demands, where the chemical resistance of the flooring in terms of cleanability is crucial.

Even in other environments like schools or in areas where food contact is important, PU floorings offering "easy to clean" properties significantly increased their market share.

Considering cruise ships for instance, the demand is to provide a system with the best weather resistance, durability, UV protected coating and excellent optical properties.

Unsurprisingly for these kind of application fields, the PU flooring market is growing as well. Besides the expectations with regards to optical performance, tightening international legislations and regulations like AgBB conformity and VOC have to be fulfilled as well.

Castor oil based polyols have been approved in polymer floorings as a UV stable and impact resistance alternative to epoxy systems for a long time. They can be

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used as primer and self-levelling top coats. Especially 100% polyol based primers are used on damp concrete or oily concretes.

General layer build up

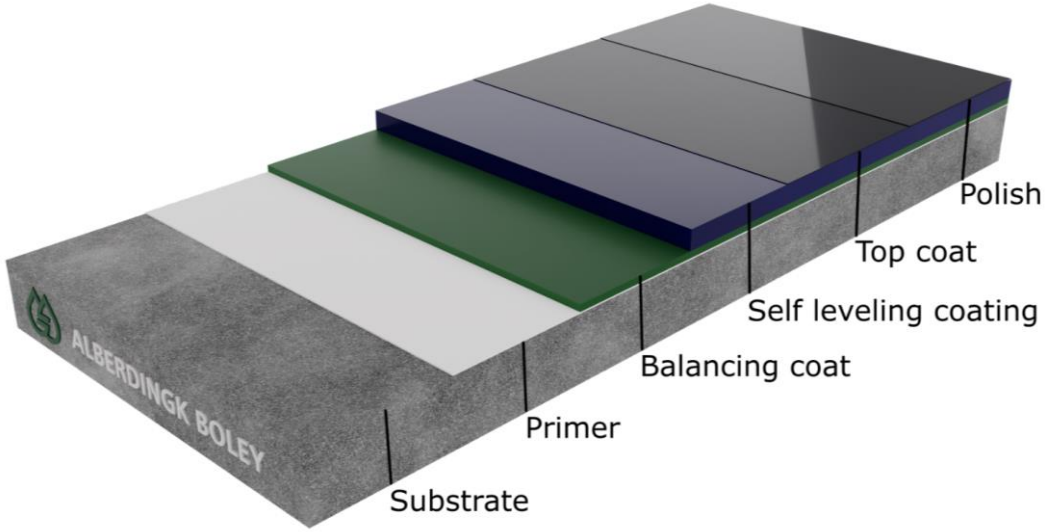
Flooring systems always have a multi-layer build up.

The primer layer seals dust to the concrete and provide adhesion to the following layers.

It is followed by a **balancing or levelling layer** / mortar which fills up pours and has 1mm film thickness.

Then, the most important layer which is called **self-levelling coating** is being applied. This coating provides the physical and chemical resistances and of course the color and optical appearance.

Areas with high foot or machine traffic will also need a **top coat** which is mainly solvent or water based and can be reworked with a polish.



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Concrete as a substrate

Concrete can be a challenging substrate for coatings. It is porous, contains additives, oils and has a high pH value which leads to saponification of polyurethane systems. Further, old concrete can lose its solidity, therefore it needs additional preparation.

Quality of concrete:

bad good

Primer

Primer (usually applied with layer thickness of 0.2 - 0.3mm ≈0.4 kg/m^2, depending on the substrate) are used for pore wetting and glueing dust to the substrate. Additionally, they provide adhesion to the following layer.

The choice of the primer depends on the condition of the substrate and on the type of polyol / dispersion chemistry which will be applied on it. For spoiled or damp surfaces we recommend to use **ALBODUR® 912** with Suprasec® 9584.

The oily character of our poyols wets oily and damp surfaces much better than water based systems.

The high amount of polyurea (from the isocyanate water reaction), which occurs on the surface, leads to perfect adhesion of the following layers.

On fresh (green) concrete the primer must be a self-crosslinking acrylic like **ALBERDINGK® AC 2403** or styrene based. Otherwise the following layer will suffer from saponification.

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Levelling primer and self-levelling layers

Aromatic cured systems

Self levelling coatings have the following purposes:

- Mechanical and chemical resistance
- Appearance
- Conductivity (Antistatic)
- Anti-Slip properties

They are usually applied with layer thickness of 1-3mm (1mm: ≈1,5kg/m^2). All ALBODUR® grades can be suitable. The most appropriate grade of ALBODUR® depends on the required elasticity and hardness. In order to develop the best inter-coat-adhesion the primers should be harder than the top coats.

The correct choice of the type of **ALBODUR®** depends on the required elasticity and hardness. In order to develop the best inter-coat-adhesion the primers should be harder than the top coats.

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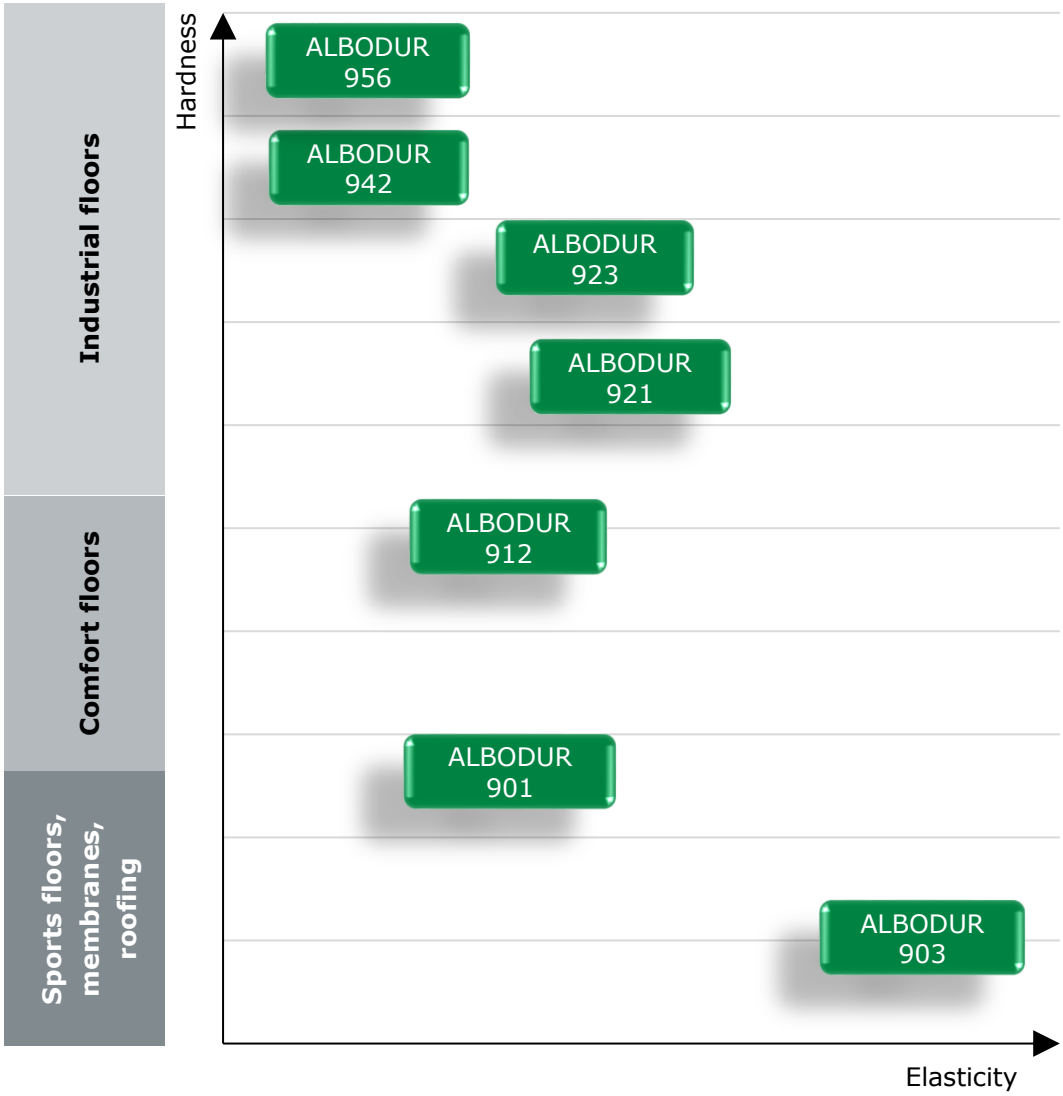
Hardness and Elasticity comparison of ALBODUR® - MDI based Polyisocyanate Cured



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Aliphatic cured systems

UV-stable and low temperature curing systems are becoming more important application requirements, especially for exterior applications.

The very first approach from ALBERDINGK BOLEY to meet nowadays demands were the developments of **ALBODUR® 955**, **ALBODUR® 956** and **ALBODUR® 965**. These products, being part of the **ALBODUR®-**technology platform, are based on renewable resources but still contain chemical structures, which allow to combine a hydrophobic part with high reactive groups to achieve higher reactivities and functionalities to be able to crosslink with HDI (Isocyanates).

Aliphatic systems behave vice versa to aromatic systems. The hardness has to be achieved with the polyol and the elasticity is supported by the isocyanates.

Castor oil is not fully light stable because of its double bonds.

In order to push performance beyond current limits and to fulfil the market requirements mentioned earlier, ALBERDINGK BOLEY's strategic goal was to develop a product based on natural resources, which is not only unique because of its absolutely crystal clear appearance as a neat resin, but also outperforms the current market standards thanks to its excellent UV stability.

ALBODUR® 1054 consists of at least 65% renewable resources and therefore yields an environmental friendly, VOC- and odour-free aliphatic PU system, which is AgBB compliant, offering a value-added solution to the future needs of the floor coating industry.

The low OH-value leads to a low demand of hardener which makes the product more economical and less sensitive to water absorption.

The handling of the polyol is comparable to the standard resin floor technology and fits perfectly into most product portfolios.

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The product is pale in colour which offers the opportunity to apply thick clear films as decorative top coat:

Initially:

ALBODUR® 1054
x-linked with aliphatic PIC

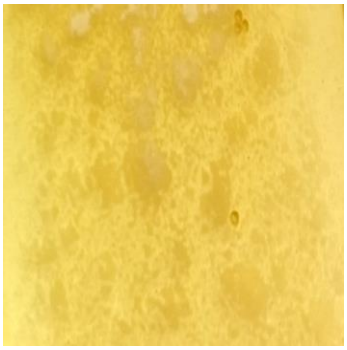
Market Standard
x-linked with aliphatic PIC

UV-stable epoxy

After 1500h QUV:

ALBODUR® 1054
x-linked with aliphatic PIC

Market Standard
x-linked with aliphatic PIC



UV-stable epoxy

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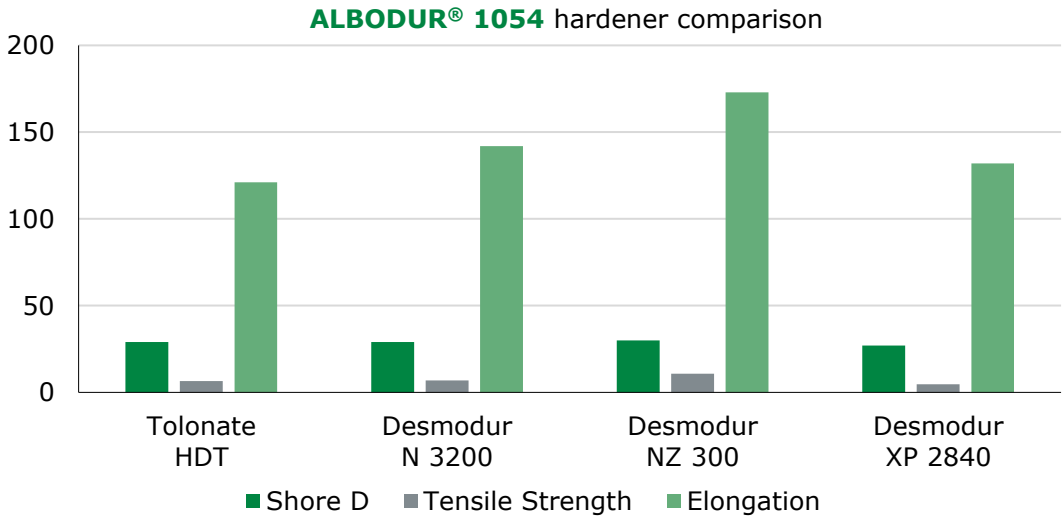
Impact of isocyanate and catalyst

Due to the aliphatic technology, the impact of the hardener and the catalyst is as strong as the impact of the polyol. The best catalysing effect was observed with DOTL types, especially Dioctyltincarboxylate. Additional combination products like amine modified DOTL DABCO DC 2 develop a comparable curing profile like aromatic systems.
Most hardeners are compatible with **ALBODUR® 1054** but the best hardness development can be observed with isocyanate blends which contain IPDI technology e.g. Desmodur® NZ 300 or Vestanat® 2354.



The impact can be also observed on elongation and tensile strength measurements. The resin is very compatible and can be combined with polyethers, polycarbonate and CAPA® polyesters to increase elongation or resilience.

Compatibility with CAPA® systems

	Compatibility	Hardness increase	Flexibility increase	Hardener compatibility
CAPA® 3031	+++	-	+	+++
CAPA® 2043	++	-	++	++
CAPA® 4101	+	++	-	+

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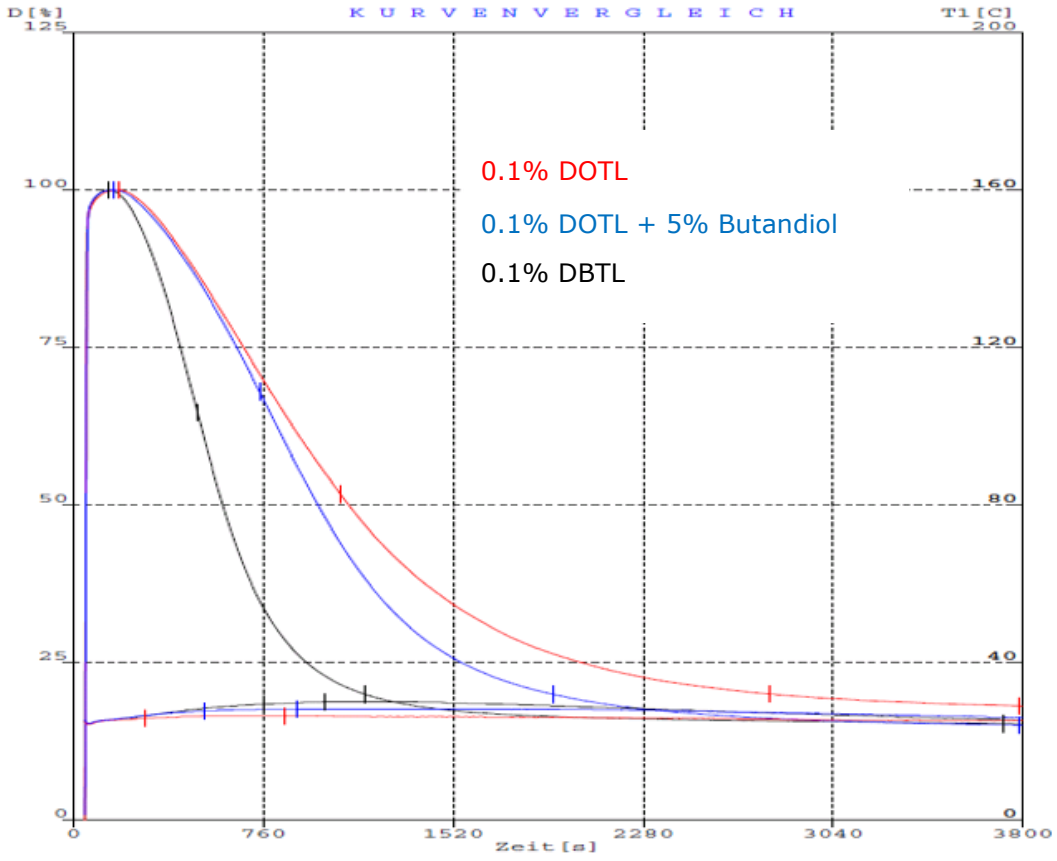
Additional chain extenders like Butandiol or Hexandiol can be used to increase reactivity.

Workability and pot-life: DBTL vs. DOTL



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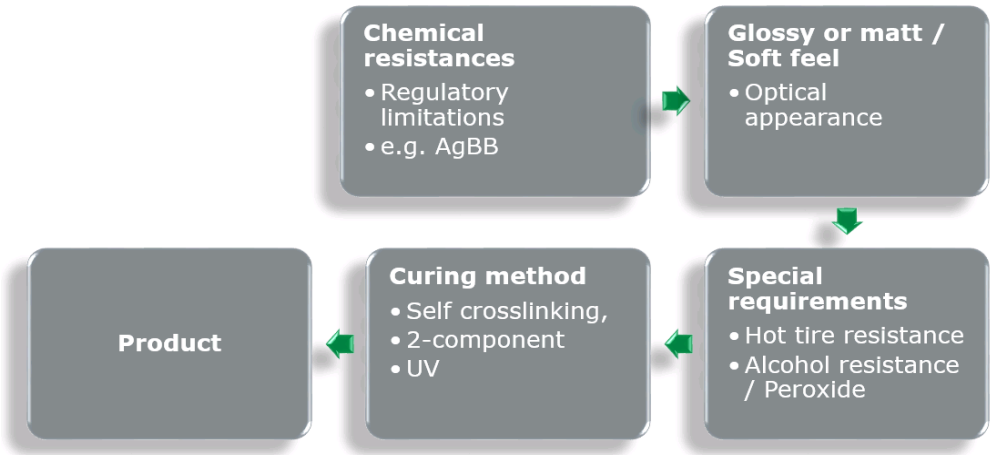
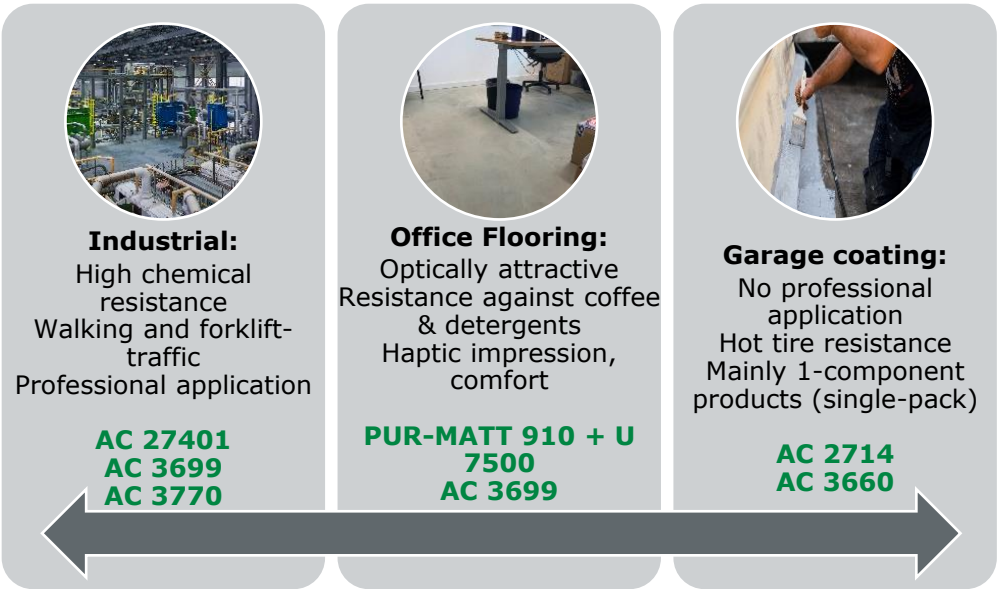
Topcoat

Topcoats (usually applied with layer thickness of 0.06 - 0.1mm (≈0.1 - 0.6kg/m^2) can provide scratch resistant and UV stable surfaces and are also often used to increase anti-slip properties.

Before choosing a dispersion for a top coat of flooring systems the following questions should be asked in order to not miss important criteria:



Generally, flooring topcoats can be divided into three product groups:
For more detailed information, please see our brochure for floor coatings.



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Waterbased dispersions for 1K and 2K topcoats

ALBERDINGK®-product	Solids [%]	Viscosity [mPas]	pH-value	MFFT [°C]	Features
AC 27401	37.0-39.0	700-2,000	7.5-8.5	15	Superior chemical resistance, for matt varnishes with easy to clean properties
AC 3770	46.0-48.0	200-2,000	7.5-8.5	80	Outstanding chemical- and stain resistances, as well as hot tire resistance
AC 3699	39.0-41.0	50-500	7.0-8.0	40	Long open time, high chemical resistance and very fast drying/curing
U 7500	33.0-35.0	20-200	7-9	13	Best application properties at low VOC, Workhorse PUD
PUR-MATT 910	34.0-36.0	20-2,000	7.0-9.0	30	Best burnishing resistance, very neutral "Anfeuerung"
AFU 850	39.0-41.0	20-200	7.0-8.5	25	Amine free PUD, neutral "Anfeuerung", hard, good adhesion
AC 2714	43.0-45.0	30-300	8.0-9.0	50	Tire resistant polymer
AC 3660	39.0-41.0	20-200	8.0-9.0	55	For wet look, epoxy acrylic, high chemical resistance

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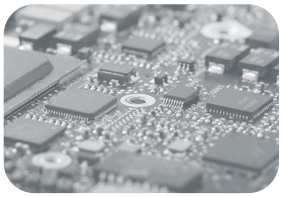
Elastomers and Sealants

Floorings (MDI-based)

Coatings (HDI-based)

Elastomers/ Sealants

Corrosion Protection



Potting resin

Adhesives 1- and 2-pack

All **ALBODUR®**-grades can also be used in can be used in elastomeric systems. Due to changing machines, diverse equipment and various handling in the industry we do not recommend specific **ALBODUR®**-types.

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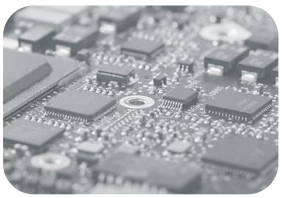
Corrosion resistance

Floorings (MDI-based)

Coatings (HDI-based)

Elastomers/ Sealants

Corrosion Protection



Potting resin

Adhesives 1- and 2-pack

The low viscosity and the high hydrophobic behaviours is very beneficial for heavy duty coatings. In our studies we observed a correlation between the hardness of the polyol (high OH value) and the corrosion resistance: The harder, the better!

Additionally, we recommend to use special aromatic and aliphatic hardeners for metal adhesion.

ALBODUR®-product	Viscosity [mPas]	OH-value [mg KOH/g]	Shore D	Features
Aromatic crosslinking:				
ALBODUR® 921	600	218	60	Direct to metal, pipe coatings
ALBODUR® 942	500	318	80	Direct to metal, heavy duty coatings
Aliphatic crosslinking:				
ALBODUR® 1054	3,000	210	80	Topcoat application

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Protective DTM Top Coat based on ALBODUR® 1054
Application field: Marine and pipe coatings

Pos.	Raw Material	Amount	Product	Supplier
1	**ALBODUR® 1054**	**58.00**	**polyol**	**Alberdingk Boley**
2	ANTI-TERRA-203	0.80	dispersing agent	BYK-Chemie
3	RHEOBYK-100	1.40	rheology modifier	BYK-Chemie
4	Heucophos ZPA	20.10	corrosion inhibitor / pigment	Heubach GmbH
5	Heucorin RZ	2.00	corrosion inhibitor	Heubach GmbH
6	Bayferrox 130 M	6.70	pigment	LANXESS
7	Sylosiv A3*	4.00	molecular sieve	Grace
8	Tinuvin 1130	2.70	UV-absorber	BASF
9	Tinuvin 292	1.30	HALS	BASF
10	Dynasylan VTMO*	1.30	moisture scavenger	Evonik
11	BYK-354	0.50	surface additive	BYK-Chemie
12	BYK-358	0.50	surface additive	BYK-Chemie
13	BYK-085	0.50	defoamer	BYK-Chemie
14	TIB Kat 318 (10% in Butylacetate)	0.20	catalyst	TIB Chemicals
	Total	**100.00**		

*Moisture scavenger and molecular sieve need at least 24 hours after incorporation for the reaction with water. Afterwards it is possible to use the coating for further application.

Crosslinking:

We recommend an x-linking ratio of NCO:OH of 110% or 100.00 parts of a.m. formulation require 46.8 parts of Desmodur NZ 300.

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General Properties:

Pot-life:	ca. 40 minutes
Drying Time [120µm wft @ RT]:	
Touch dry:	ca. 5 h
Hard dry:	ca. 7h
Gloss:	ca. 89 [60°]
Cupping Test [Flexibility]:	more then 9,0mm, crack free
Impact-resistances [1kg, 1m]:	no cracks, front and reverse test
Adhesion / Crosscut:	4B / 5B

Cupping Test [Flexibility]

Impact-resistance [1kg, 1m]

Adhesion / Crosscut

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Potting resin

Floorings (MDI-based)

Coatings (HDI-based)

Elastomers/ Sealants

Corrosion Protection

Potting resin

Adhesives 1- and 2-pack

Unlike a lot of other polyols and due to its chemical structure, castor oil provides natural isolation properties and a long term heat resistance. To increase saponification stability and hardness under high temperatures, we modify castor oil into specific polyols for potting resins.

Additionally most polyols from ALBERDINGK pass the UL 94 test for cable isolation.

ALBODUR®-product	Viscosity [mPas]	OH-value [mg KOH/g]	Shore A/D	Elongation %	Features
ALBODUR® 923	3,000	234	99/75	10	Hard, good isolation properties
ALBODUR® 924	2500	232	98/65	40	Hard but flexible good isolation properties
ALBODUR® 942	500	318	99/80	15	Very hard

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Adhesives

Floorings (MDI-based)

Coatings (HDI-based)

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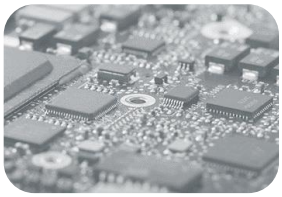
Corrosion Protection



Potting resin

Adhesives 1- and 2-pack

1-pack adhesives

For the production of moisture cured one pack systems, polyols with an elastic character, low viscosity and a high hydrophobicity are preferred. As a functional alternative to traditional PPG 2000, **ALBODUR® 102** is recommended.

The product is much more compatible with MDI and leads to an easy control and reduction of the NCO content. The final film is glossier and more storage stable than PPG types.

We recommend to exchange up to 60% of the PPG to **ALBODUR® 102**. **ALBODUR® 110** can be used as a reactive diluent.

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GREEN polyols for sustainable 1-pack adhesive and elastomer solutions

Exemplary formula ingredients	**ALBODUR®** polyols for 1-pack systems with green backbone
MDI-based isocyanate	e.g. SUPRASEC® 1306
Polypropylene Glycol (1.000 Mw, fct. 2.0)	**ALBODUR®**
Polypropylene Glycol (2.000 Mw, fct. 2.0)	**ALBODUR® 102**
Extenders	Silica, Barium sulfate
Stabilizers / Additives	Rheology modifier, pigments, defoamers, …
Plasticizer / Reactive diluent	**ALBODUR® 110**

2-pack adhesives

ALBODUR® 921 and **ALBODUR® 912** combine a high filler loading with a high tensile strength.

The products are very compatible and easy to formulate with high functional isocyanates (2.9).

GREEN polyols for sustainable 2-pack adhesive and elastomer solutions

Exemplary formula ingredients	**ALBODUR®** polyols for 2-pack systems with green backbone
Polypropylene Glycol (1.000 Mw, fct. 2.0)	**ALBODUR®**
Polypropylene Glycol (2.000 Mw, fct. 2.0)	**ALBODUR® 102**
Branched Polyether/Polyester Polyol (~3.500 mPas)	**ALBODUR® 921**
Branched Polyester Polyol	Not needed with **ALBODUR®**
Extenders	Silica, Barium sulfate, Talkum
Stabilizers / Additives	Rheology modifier, pigments, defoamers, …
MDI-based polyisocyanate	e.g. SUPRASEC® 5025

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