

NOVARES® / RUETASOLV®
for the Coating Industry





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Company Profile

Rain Carbon Inc. is a global market leader in the field of aromatic chemicals. The company's success is based on flexibility and innovation along with partnership-based cooperation with clients. With more than 150 years of experience, Rain Carbon is a competent and reliable partner for a wide range of resins and their application fields, particularly when it comes to developing innovative products to meet new challenges and to satisfy evolving regulatory and societal requirements.



On Track for Durable Surface Protection

Our Products

NOVARES® hydrocarbon resins offer high and continuous quality for a wide range of coating applications. Based on aromatic and aliphatic feedstock we develop solid and liquid specialties, manufacture in Europe, distribute via our international network and deliver to customers worldwide. Our clients benefit not only from a broad product portfolio but also from individual logistical solutions and technical application support. Our R&D and service lab provide ideas for the next generation of products reducing our carbon footprint and that of our customers.

RUETASOLV® products are non-reactive modifiers based on naphthalene or biphenyl and are suitable for coatings, casting resins, reactive systems and waterborne formulations.

Delivery Forms

- Solid resins as pastilles supplied in paper bags and big bags
- Molten resins in heatable tank container
- Liquid resins in drums, IBCs or by tank truck

Our production processes, application technology and marketing system are certified according to DIN EN ISO 9001, DIN EN ISO 14001, DIN EN ISO 50001 and OHSAS 18001 quality and environmental standards.

For coatings applications the liquid resins are popularly used to improve different properties described in this brochure. The brochure is also available for downloading at www.novares.com and www.NovaresNextGen.com.





Application Range

Our products are suitable for various applications based on different polymer chemistry. In coatings, liquid products, with low or non VOC content, improve flexibility,

hydrophobicity, corrosion resistance and wetting properties. The following chart presents the most common applications and the recommended products.

Liquid Resins and Modifiers	Properties		Functions			Compatible Coating Formulations				
	Viscosity at 20 °C (mPa.s)	OH Content (wt.-%)	Hydro-phobing	Plastifi-cation	curing of epoxy/ amine	2K PUR	2K EP	1K PUR	Poly-sulfid	Acry-lics
Aromatic Liquid Resins										
NOVARES® L 40	30 - 45	0	+++	+++	-	+++	++	+++	++	+++
NOVARES® L 100	50 - 150	0	+++	+++	-	+++	++	+++	++	+++
NOVARES® L 800	800 - 1000	0	+++	+++	-	+++	++	+++	++	+++
NOVARES® TL 10	6000 - 10000	0	+++	+	-	+++	++	+++	++	+++
NOVARES® TM 20 AS	27500	0	+++	+	-	+++	++	+++	++	+++
RUETASOLV® DI	6 - 10	0	+++	+++	-	+++	++	+++	++	+++
RUETASOLV® BP D	10 - 12	0	+++	+++	-	+++	++	+++	++	+++
Functional Liquid Resins										
NOVARES® LA 100	75 - 150	1.4 - 1.7	+++	+++	+/-	+++	+++	+	+++	+++
NOVARES® LC 15	100 - 180	1.4 - 1.6	+++	+++	+/-	+++	+++	+	+++	+++
NOVARES® LA 300	300 - 400	1.7 - 2.2	+++	+++	+/-	+++	+++	+	+++	++
NOVARES® LA 700	700 - 800	2.3 - 2.8	+++	+++	+	++	+++	+	+++	+
NOVARES® LA 1000	900 - 1300	1.8 - 2.4	+++	+++	+/-	++	+++	+/-	+++	+
NOVARES® LA 1200	1200 - 1500	2.4 - 2.7	++	+++	++	++	+++	-	+++	+/-
NOVARES® LA 1900	2000 - 2700	2.6 - 3.2	++	++	++	+	+++	-	+++	+/-
NOVARES® LS 500	400 - 1400	7.0 - 7.6	++	++	+++	++	+++	-	+++	+/-
New Generation of Functional Liquid Resins										
NOVARES® LM 100	75 - 150	1.4 - 1.7	+++	+++	+/-	+++	+++	+	+++	+++
NOVARES® LM 300	300 - 400	1.7 - 2.2	+++	+++	+/-	+++	+++	+	+++	++
NOVARES® LM 700	700 - 800	2.3 - 2.8	+++	+++	+	++	+++	+	+++	+
NOVARES® LM 1000	900 - 1300	1.8 - 2.4	+++	+++	+	++	+++	+/-	+++	+
NOVARES® LM 1200	1200 - 1500	2.4 - 2.7	++	+++	++	++	+++	-	+++	+/-
NOVARES® LM 1900	2000 - 2700	2.6 - 3.2	++	++	++	+	+++	-	+++	+/-
NOVARES® LM 5000	4000 - 6000	3.7 - 4.4	++	+	+++	+	+++	-	+++	+/-
NOVARES® LCM 500	500 - 1500	6.7 - 7.1	+++	+++	+++	+	+++	-	+++	+/-
NOVARES® MP 50	(Solid)	7.9 - 8.5	++	+/-	+++	+	+++	-	+++	+/-
Water-miscible Liquid Resins										
NOVARES® W	50-150	0	+++	+++	-	+++	+++	-	-	+++
NOVARES® WA7	1200- 2300	6.5- 7.1	++	++	+	+	+++	-	-	+

+++ excellent + Suitable +/- Selective usable - not recommended

General Properties

Liquid hydrocarbon modifiers are chemically inert and lipophilic. The low molecular weight results in a low glass transition temperature, a high solvency power and low viscosity. For different applications these material properties are generally benefit for:

- lowering viscosity of formulations
- improvement of resistance against water, chemicals and corrosion
- improvement of adhesion
- increasing flexibility

These positive effects of NOVARES® liquid hydrocarbon modifiers are a result of the chemical structure of the products and their compatibility in different formulations and chemical systems, e.g. epoxy formulations for heavy corrosion protection, industrial and civil engineering applications.

Viscosity Reduction

The very low viscose NOVARES® L 40, NOVARES® L100 and RUETASOLV® DI are low VOC liquids with high dilution power. In coating formulations, they are ideal choices for a

significant reduction of viscosity. The low VOC content of the products make them particularly useful for high solid systems.

Fig. 1
Dilution power to Epikote 828:
NOVARES® L 40 in comparison to
alternative diluents

NOVARES® L 40
RUETASOLV® DI
Xyl-Formaldehyde resin
Benzyl alcohol

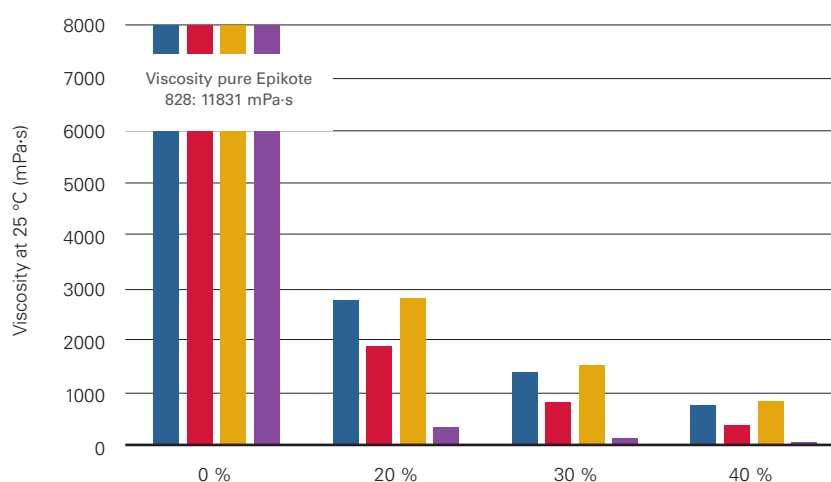
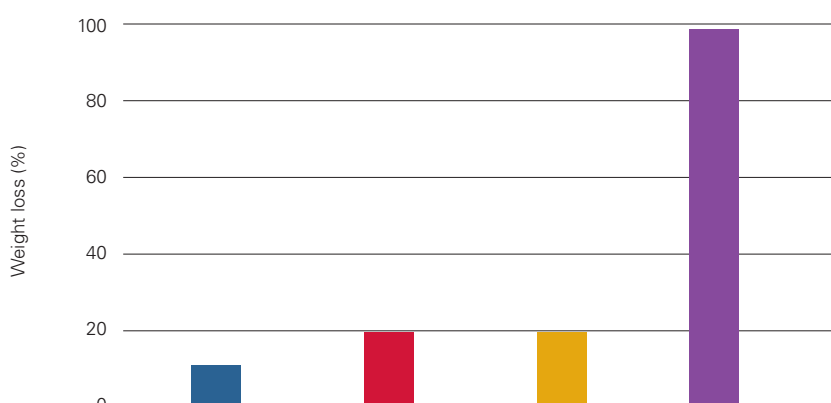


Fig. 2
Weight loss of pure material at
105 °C/2 hrs

NOVARES® L 40
RUETASOLV® DI
Xylene-Formaldehyde resin
Benzyl alcohol

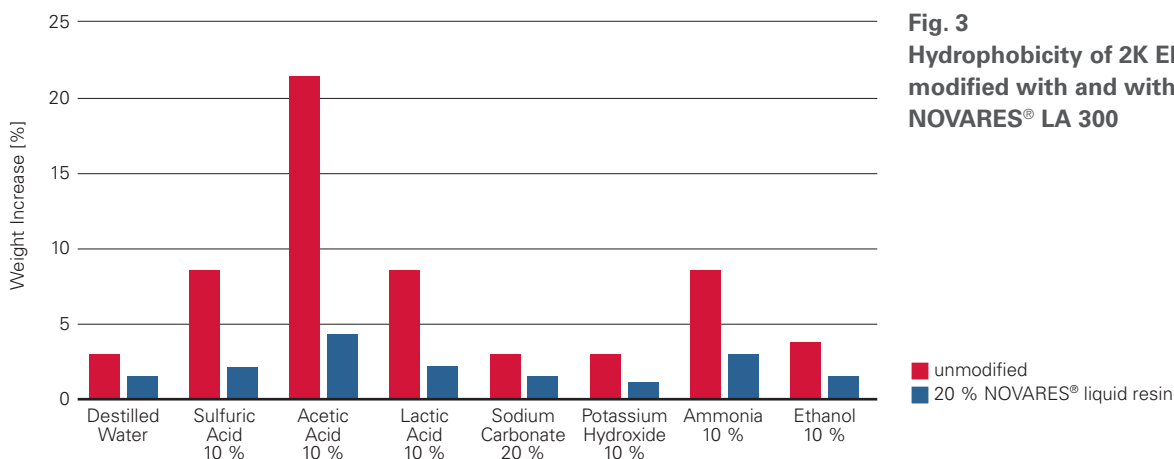




Hydrophobicity and Chemical Resistance

NOVARES® resins and RUETASOLV® products have hydrophobic aromatic structure that significantly increases the resistance of civil engineering and corrosion-protection systems against moisture and aqueous media. As shown below, after 6 months storage in a range of aqueous media, the NOVARES® modified epoxy system exhibited a much lower weight increase than the unmodified reference system.

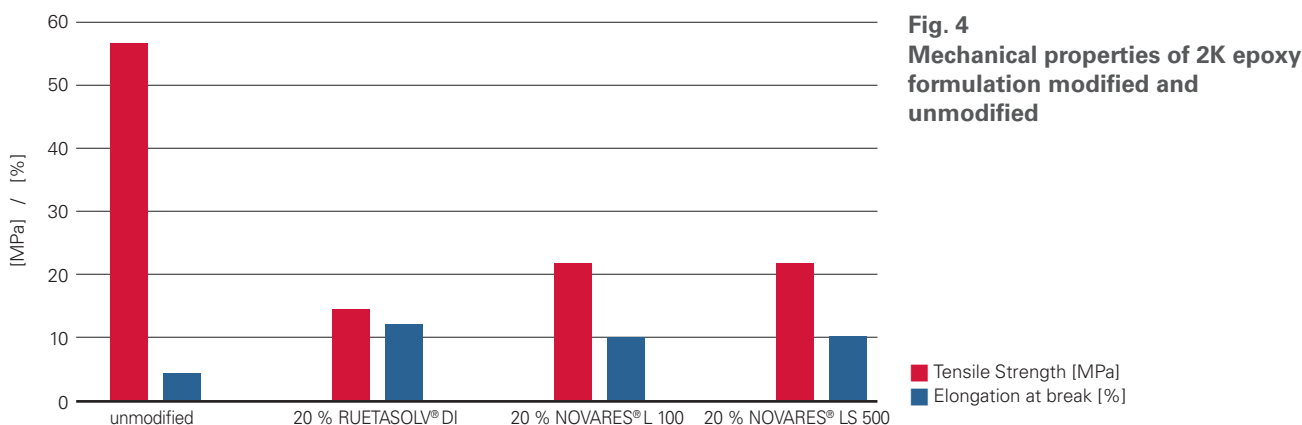
The modified epoxy systems show a much better performance under heavy environmental conditions, compared with unmodified formulations. Because of their positive characteristics the modifiers generally help to extend the life-span of a formulation and provide an increased surface protection.



Flexibility and Plasticizing

NOVARES® and RUETASOLV® modifiers are liquid products with low T_g and high compatibility to a wide range of chemical macromolecules. In coating films, they work as internal softener in the polymer network, reduce tensile strength,

increase the elongation and the low temperature flexibility. The high compatibility ensures stable embedding of the products in coating films and prevents migration.



Acceleration in Epoxy Formulations



NOVARES® LS 500, LM 5000 and LCM 500

High solid or VOC free epoxy formulations often contain large number of liquid modifiers to optimize the manufacture, handling and application processes. For example, reactive or non-reactive diluents are commonly used to reduce the viscosity, applications on steel or concrete substrates need flexibilized formulations containing plasticizers or, for safe handling reason, liquid substance is added in A or B components to obtain an easy processible mixing ratio for the site.

The intensive use of the modification agents is often accompanied by drawbacks in curing speed due to the dilution effect and results in longer reaction time. To balance the mismatch, modifiers with high phenolic OH content like NOVARES® LS 500, LM 5000 or LCM 500 are recommended. The relatively low viscosity, bulky structure and acidic nature of the products make them to multifunctional modifiers improving viscosity, flexibility, wetting simultaneously at an accelerated or remained curing speed particularly at low application temperature.

The products are typically used in quantities between 5-15 % calculated on solid resin. It can be used in combination with NOVARES® L, LA, LM series and RUETASOLV® products, when dilution and acceleration must be balanced in a desired way.

NOVARES® LS 500, LM 5000 and LCM 500 belong to the category of accelerators, which was represented in the past by different alkylphenols, for example, nonylphenol.

NOVARES® LS 500 is an alkylphenol free accelerator, while LM 5000 and LCM 500 are accelerators based on preparations of proprietary phenolic polymer available under the product name NOVARES® MP 50. NOVARES LM 5000, LCM 500 and MP50 are developed under the promise for a long-term safe use without regulatory concern. Especially LCM 500 based on REACH exempted polymer and a biophenol offers a proper handling ability, comparable activity to standard alkyl- and arylphenol, high flexibilization, high chemical resistance with a high bio content.

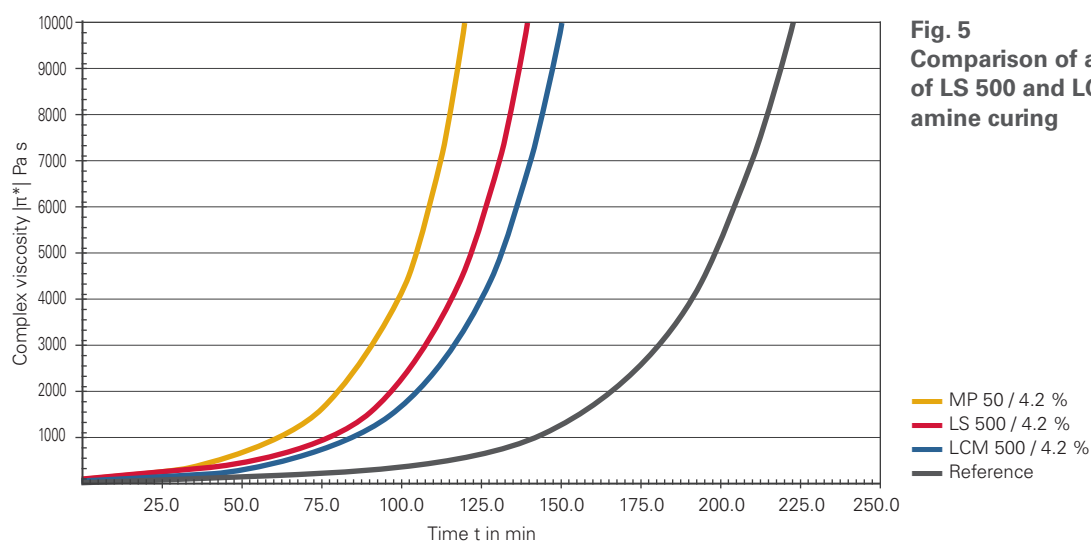


Fig. 5
Comparison of acceleration effects
of LS 500 and LCM 500 in epoxy/
amine curing

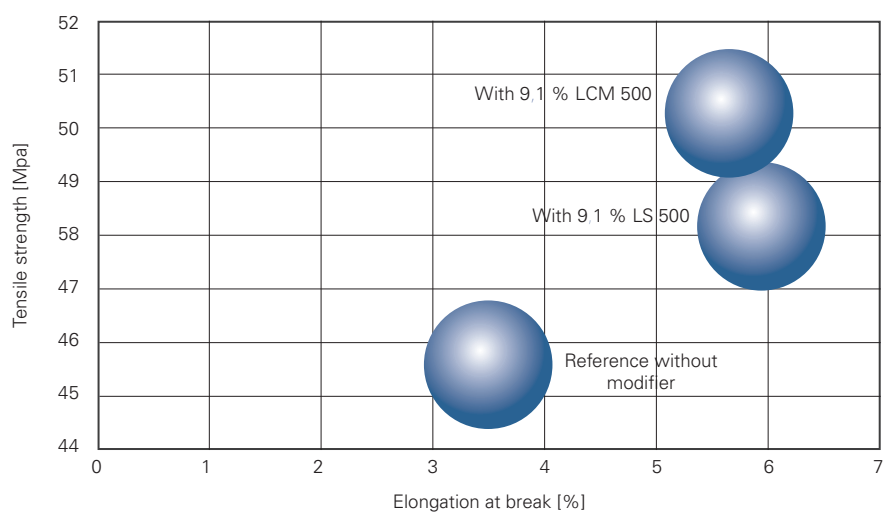


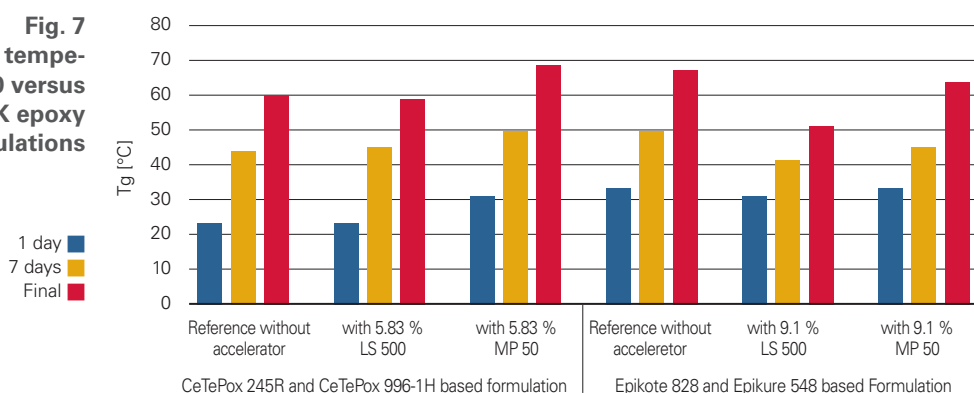
Fig. 6
Plastification of 2K epoxy
formulation by LS 500 and LCM 500

NOVARES® MP 50

NOVARES® MP 50 is a proprietary phenolic polymer with high OH content up to 8.5 wt.-%. The polymeric structure leads to a softening point of the product around 50 °C. For formulators with own handling capability NOVARES® MP 50 is available in 100 % active content. It is VOC free, almost water white, soluble in common solvents, diluents and

amine hardeners. In the application in epoxy coatings it is a strong accelerator, has less impact on glass transition temperature of the system, is stable anchored in epoxy network and results in improved solvent resistance and migration stability.

Fig. 7
Impact on glass transition temperature of NOVARES® MP 50 versus NOVARES® LS 500 in 2K epoxy formulations



Optimization of Epoxy Formulation

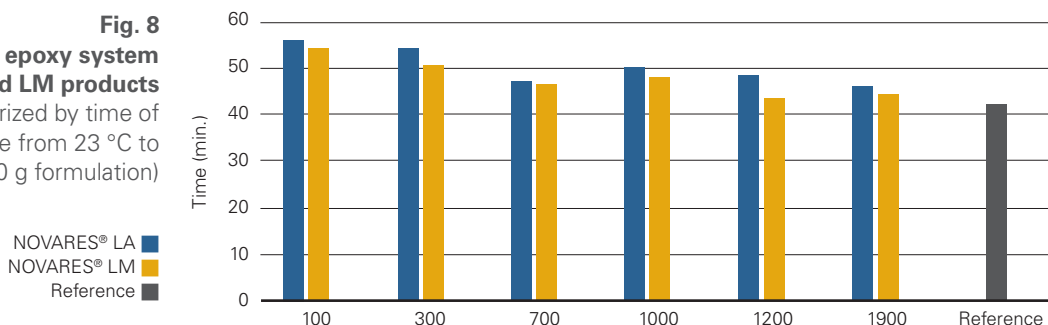
NOVARES® LA and LM series

NOVARES® LA series is well established modifiers for the epoxy formulations. Wherever plastification, hydrophobicity and improved resistance against corrosion and chemicals are required, LA series is the first choice. LA products are offered in different OH-contents and viscosities to match the requirement in the formulations with regard to compatibility, viscosity, curing speed and wetting properties.

NOVARES® LM series is drop-in offset of LA series, which will be under some application constraints in the light of new REACH decision. LM series are preparations based on NOVARES® MP 50 and a liquid non-functional resin, inherits the same nomenclature of LA and specifications. Each LM grade has same or very similar application properties like the respectively LA grade with the exception of mechanical property. As displayed in Fig. 10 LM series outperforms LA grade by significant higher elongation at break at high tensile strength.

Fig. 8
Impact on pot life of epoxy system by LA and LM products

The pot life is characterized by time of temperature increase from 23 °C to 40 °C (100 g formulation)



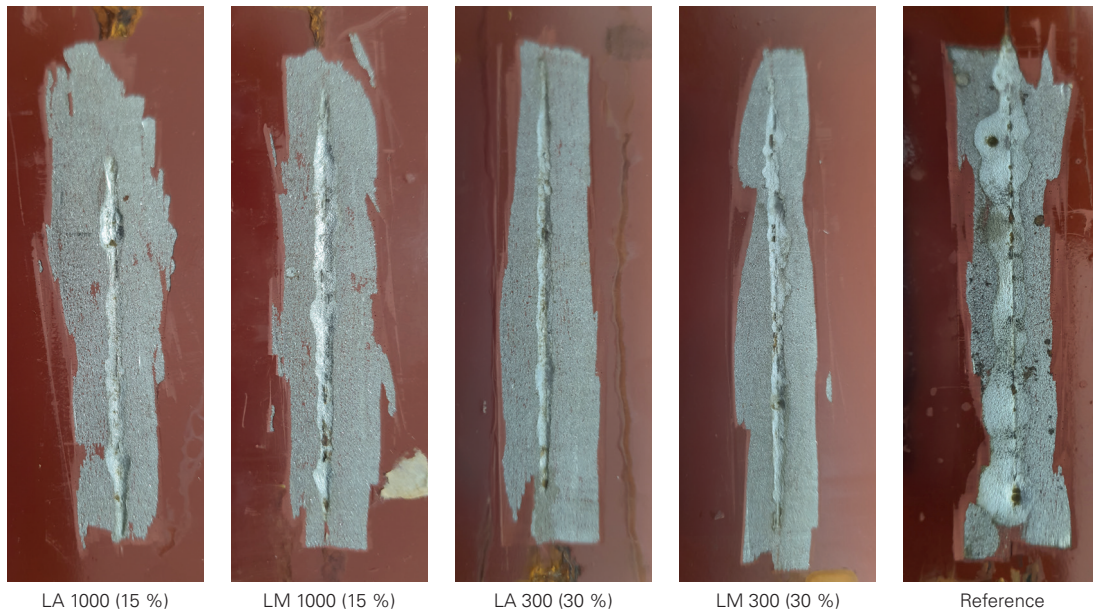
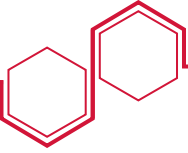


Fig. 9
Comparison of corrosion resistance of epoxy primer using LM and LA can improve corrosion resistance at the same extent

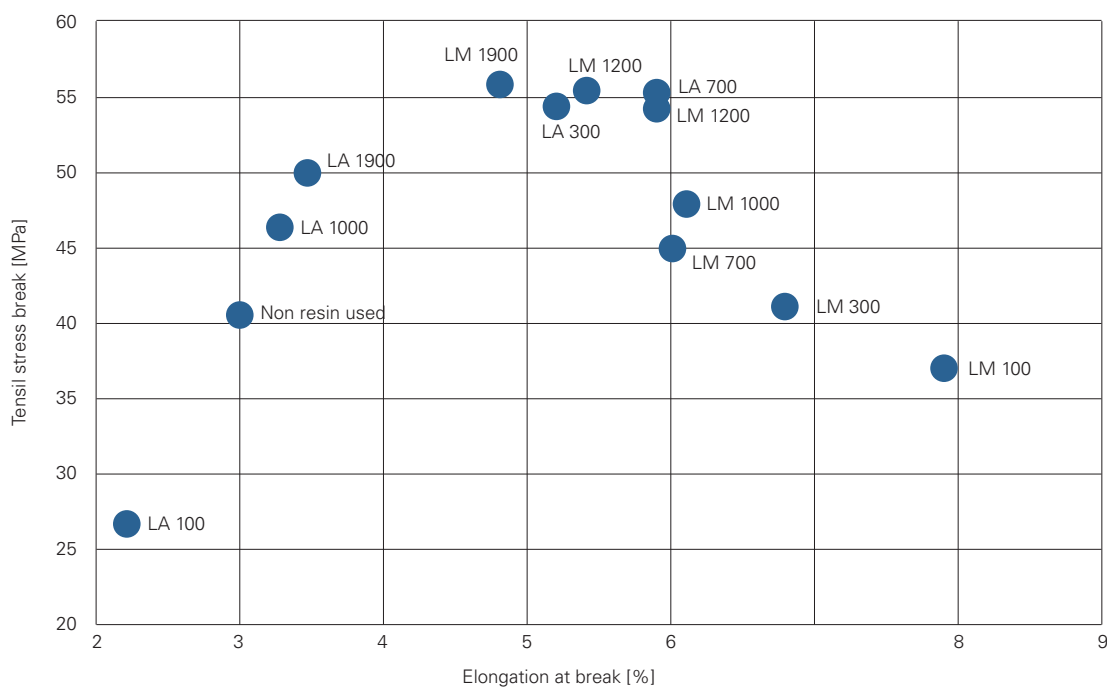


Fig. 10
Comparison of LA and LM series in flexibilization performance in epoxy coatings. LM series generally leads to a higher flexibility and maintains the high strength

Benzyl Alcohol Replacement in Epoxy Systems

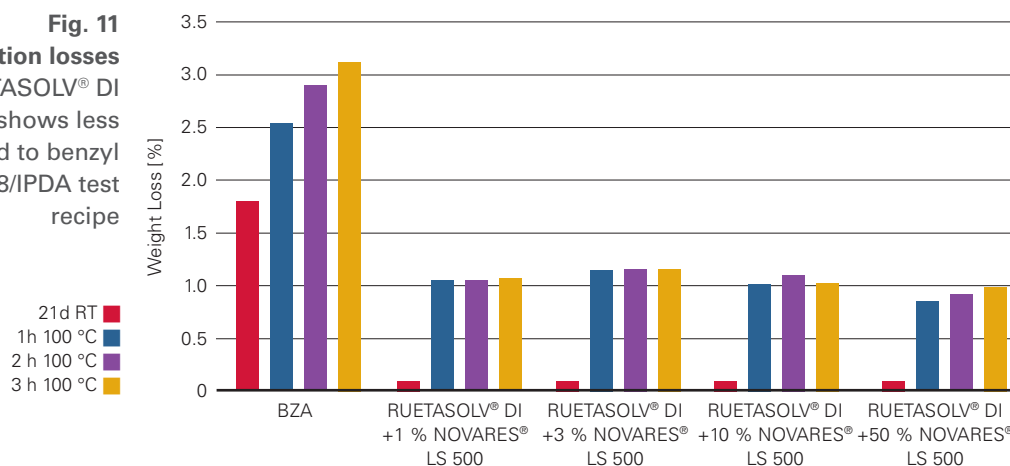
In conventional epoxy systems benzyl alcohol is widely used to reduce the viscosity, speed up curing and to improve flexibility. But due to the low boiling point benzyl alcohol is counted as a VOC in some regions. RUETASOLV® DI is capable to achieve the same viscosity reduction and high flexibility like benzyl alcohol, but without being a VOC.

In combination with LS 500 the product can match the complete application profile of benzyl alcohol, including the acceleration effect.

Fig. 11

Evaporation losses

The combination of RUETASOLV® DI and NOVARES® LS 500 shows less evaporation compared to benzyl alcohol in an Epikure 828/IPDA test recipe



The combination of NOVARES® LS 500 and RUETASOLV® DI serves as adjusting screw for curing speed and viscosity of a hardener. Formulators can either dilute the viscosity by a

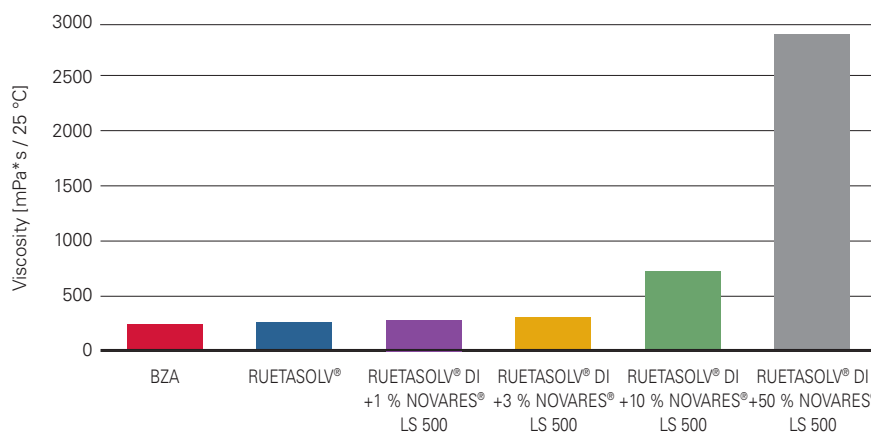
high dosage of RUETASOLV® DI or alternatively accelerate the curing by a higher dosage of NOVARES® LS 500.

Fig. 12

Viscosity

RUETASOLV® DI and benzyl alcohol modified hardeners show a similar viscosity range.

With an increasing amount of NOVARES® LS 500 the viscosity of the hardener increases





Improvement of Alkyd Applications

With more than 30 % market share, the alkyd coatings are the biggest solvent based coating type in the market. They are popular for metal-, wood-, maintenance- and decorative coatings. Most of such oil based binder systems need proper driers to support the drying and hardness development.

Additional to driers, the use of solid hydrocarbon resins is an alternative way to improve the drying time. Mechanical properties, solid content and hydrophobicity. These enhancements contribute to long durability and reliability of the coatings.

Test Formulation based on Vilkdy 188X75

Components	Weight in %
Alkyd resin	71.67
Low aromatic white spirit	18.78
Hydrocarbon resins*	8.06
Calcium (4 %) driers	0.62
Zirkonium (18 %) driers	0.75
Cobalt (6 %) driers	0.62
Total	100.0

*Dosage of hydrocarbon resins is 15 % based on alkyd binder solids. In the recipe, the resin is used as a 50 % dilution in solvents.

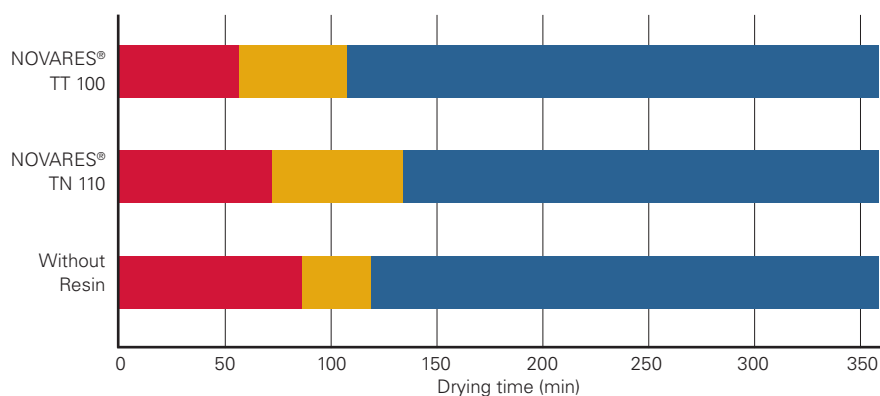


Fig. 13
Drying time

Best results were achieved with NOVARES® TT 100

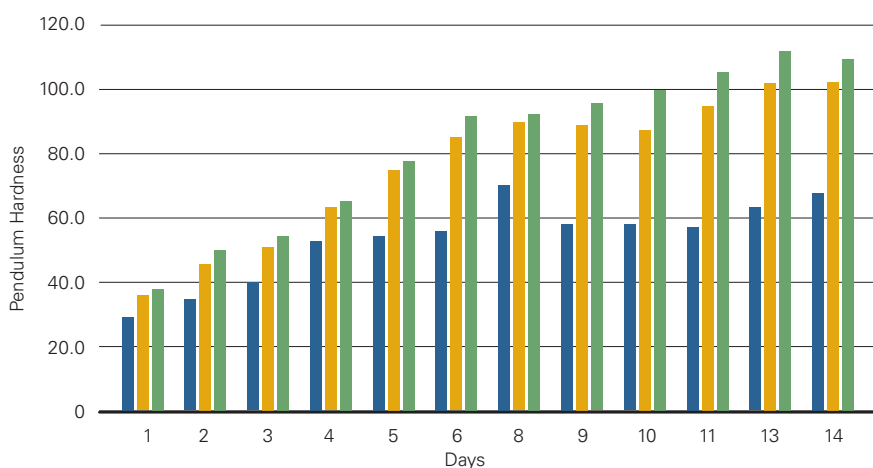


Fig. 14
Hardness improvement

NOVARES® solid hydrocarbon resins improve the hardness of alkyd coating formulations

Pot Life Optimizing of Polyaspartic Systems

Polyaspartic coating systems are known for their fast drying, high corrosion resistance and high mechanical strength. On the other hand, the fast curing often causes handling problems. Due to their low viscosity, chemical inertness and high compatibility, our aromatic modifiers are used to optimize polyaspartic formulations in:

- enhancing chemical and corrosion resistance
- optimizing the application process by accelerating curing or extension of pot life
- improving flexibility
- acting as low/non VOC diluents
- improving surface wetting properties

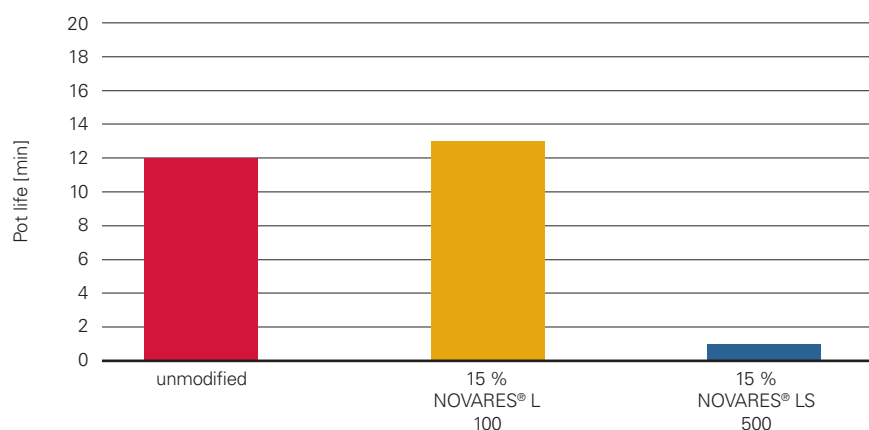
Test Formulation

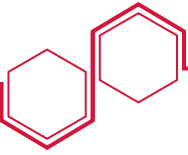
Components	Weight in %		
	unmodified	NOVARES® LS 500	NOVARES® L 100
NH-functional aspartic ester	60.6	59.5	51.8
HDI based isocyanate	39.4	38.5	33.2
NOVARES® modifier		2.0	15.0
Total	100.0	100.0	100.0

NOVARES® modifiers can be used to adjust the pot life of the formulation according to customized needs.

OH-free modifiers extend the pot life by diluting the reactive components. OH-functional modifiers can be used as catalyst.

Fig. 15
Pot life of a polyaspartic formulation
 NOVARES® L100 extends the pot life
 whereas NOVARES® LS 500 accelerates the curing

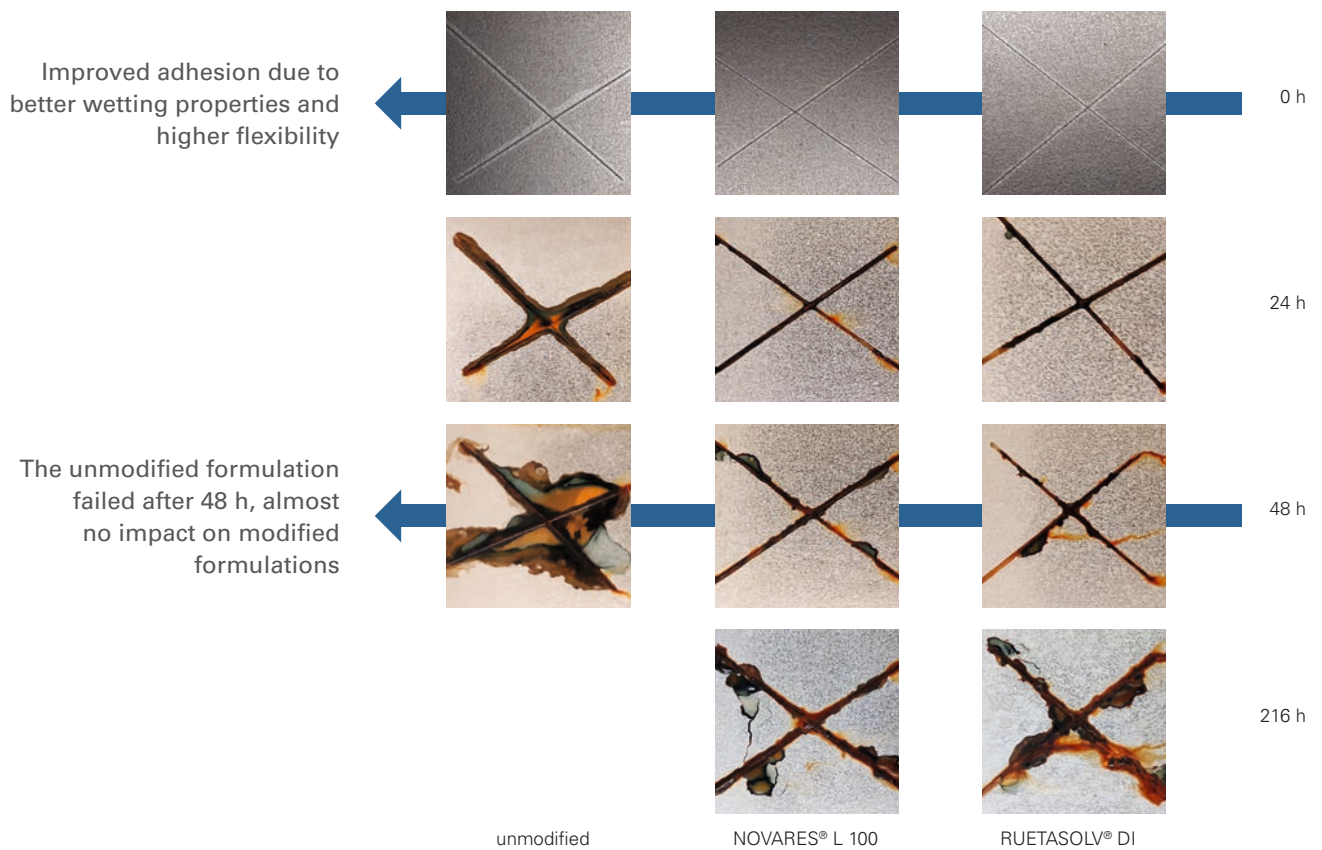




Fast curing speed and insufficient wetting often provoke bad adhesion of polyaspartic coatings. NOVARES® products are useful to prolong the pot life, improve wetting properties and

increase hydrophobicity. This results in a better adhesion and anticorrosive performance.

Fig. 16
Comparison of corrosion resistance
of polyaspartic systems without and
with modifiers



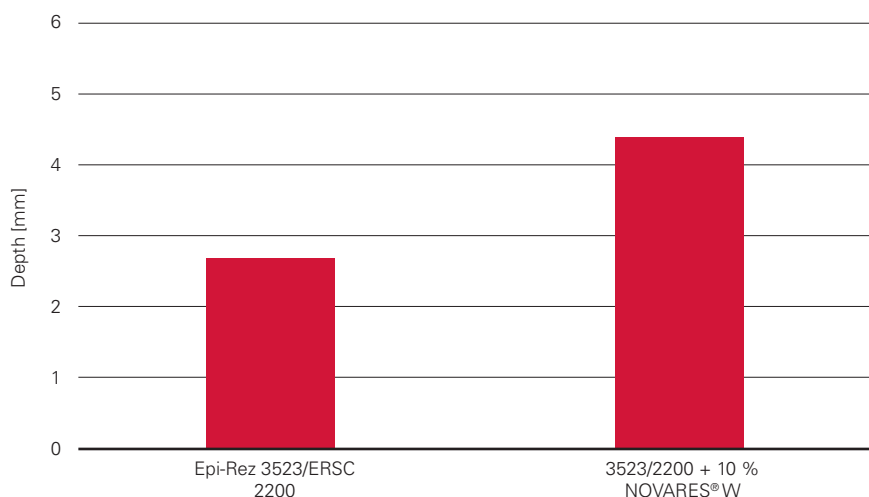
Modification of Waterborne Formulations

NOVARES®W and NOVARES®WA 7 are water miscible modifiers compatible with a wide range of different waterborne coating systems based on reactive binders like epoxy, polyurethane, as well as physical drying dispersion of acrylic, PVA, PUR, etc.. The aromatic backbone, low molecular weight and compatibility of the modifiers improve coating formulations in many aspects:

- Enhanced flexibility
- Boost of chemical resistance
- Increase of salt spray resistance
- Improvement of pigment wetting and grinding
- Decrease of the glass transition temperature of the polymer and improvement of the film coalescing
- Improvement of levelling

Fig. 17 and 18 show the performances of NOVARES®W in waterborne 2 K epoxy anticorrosion formulations.

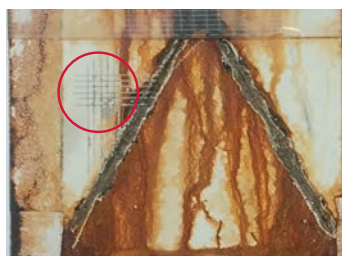
Fig. 17
Erichsen test of a waterborne 2K epoxy formulation
NOVARES®W improves the flexibility in clear coat, as well as pigmented formulations



The improvement of wetting property leads to improved adhesion, hydrophobicity and enhanced anticorrosive properties.

Especially the results of the continuous condensation test demonstrates these benefits.

Fig. 18
Improvement of corrosion resistance of waterborne 2K epoxy formulation by NOVARES®W

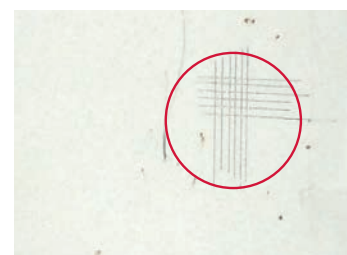


Salt spray test result of a 2K epoxy white coating after 1000 hrs treatment

unmodified



7.5 %
NOVARES®W



Result of 1000 hrs continuous condensation test on a 2K epoxy white coating

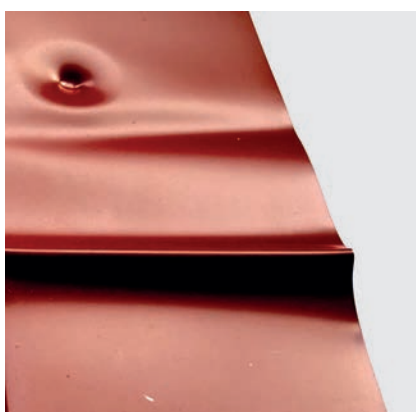


In waterborne acrylic systems NOVARES®W is a capable aromatic modifier to improve wetting properties towards fillers, pigments and substrates. Like in other formulations the product supports flexibility, hydrophobicity and chemical

resistance of the coating film. Additionally NOVARES® W is recommended as VOC-free coalescent agent to replace partially or completely the common coalescent agent in formulations.

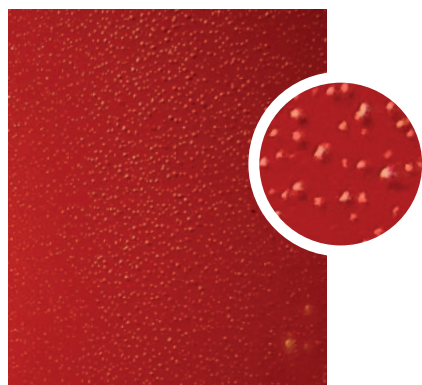


NOVARES®W



unmodified

Fig. 19
Improvement of surface properties
NOVARES® W improves pigment wetting and dispersion, which results in improved surface properties, especially gloss and levelling



unmodified

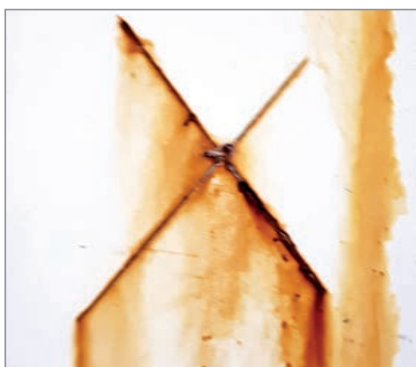


+5 % NOVARES®W

Fig. 20
Improvement of hydrophobicity
Hot water immersion test
(24h @ 60 °C)
The unmodified formulation failed due to heavy blistering. No blisters on modified formulation



Waterborne Acrylic



7.5 % NOVARES®W

Fig. 21
Results of 240 hrs corrosion test of a water-borne acrylic coating
NOVARES® W improves the resistance

NOVARES® and RUETASOLV® in PUR-Systems

Polyurethanes are an other important reactive formulation type with a wide range of applications, including civil engineering and corrosion-protection.

The results below show the effect of NOVARES® liquid resins and RUETASOLV® products in a PUR system based on a polyether polyol cross-linked with diphenylmethane diisocyanate.

Non-functional modifiers such as RUETASOLV® and NOVARES® L 100 reduce the viscosity depending on the concentration level. A rise in the viscosity of the formulation can be observed when the phenolic liquid resins are used. The phenolic group is reactive with isocyanates, particularly with aromatic isocyanates.

As non-reactive component using of NOVARES® liquid resins or RUETASOLV® products in PU formulations leads to dilution of the reactive components. This results commonly in a prolonged pot life and handling time.

Fig. 22
Viscosity adjustment using
NOVARES® and RUETASOLV®
products

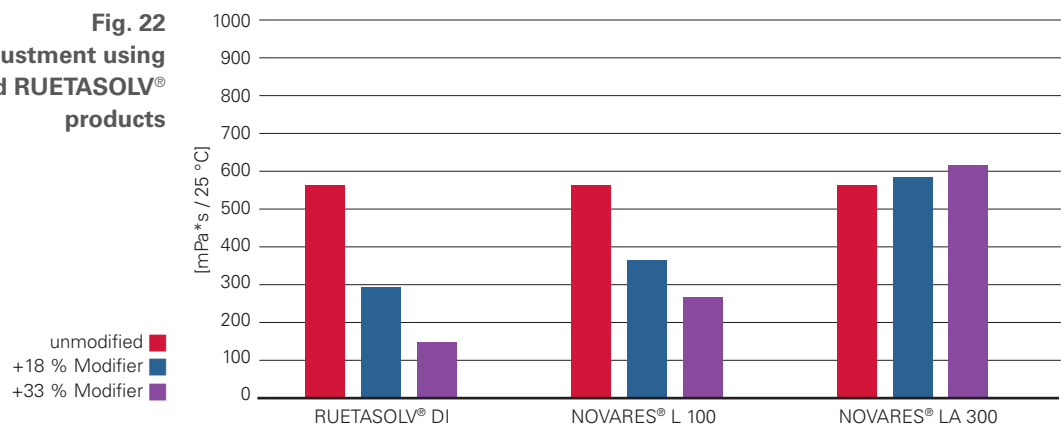
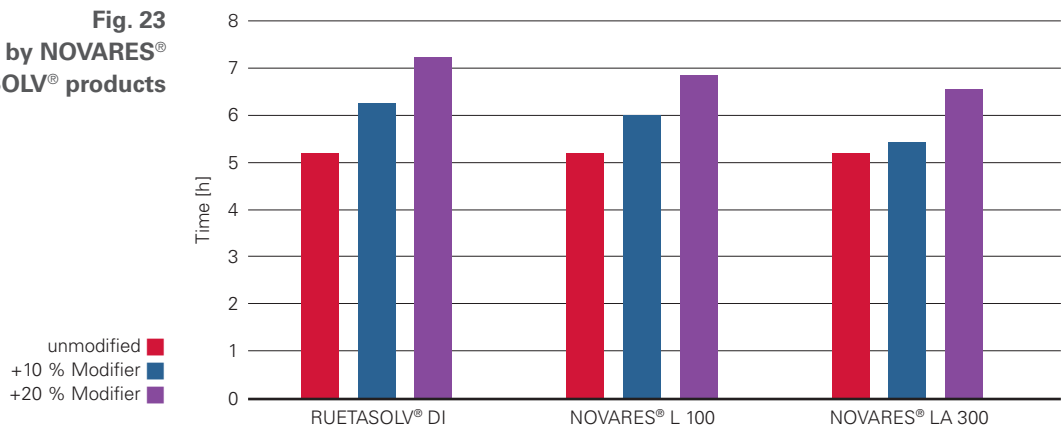


Fig. 23
Prolonging of pot life by NOVARES®
and RUETASOLV® products

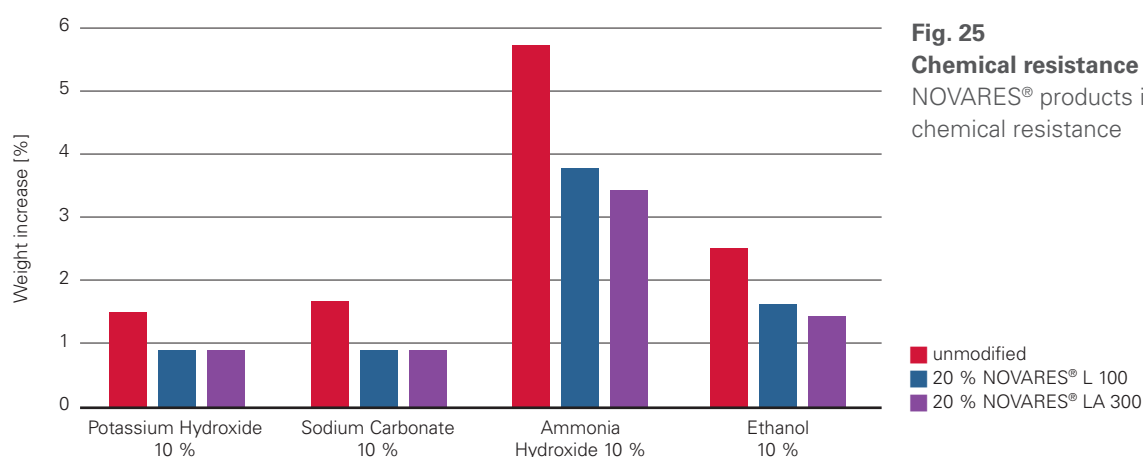
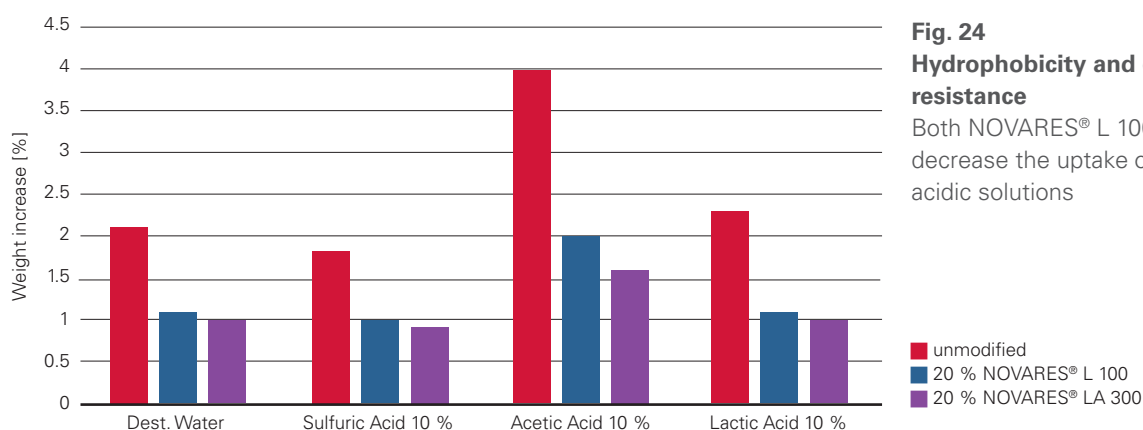




Water and Chemical Resistance

The aromatic structure of NOVARES® resins improves the hydrophobicity, both during and after the curing of the PUR system. Test specimens of modified and unmodified PUR systems were stored for 6 months in the below mentioned media and their weight increases were determined.

The positive effect of the NOVARES® resins can be clearly seen in the graphs below. The modified systems exhibit a much lower increase in weight than the unmodified reference system. Using NOVARES® modifiers in PUR provides higher chemical resistance and consequently a reliable, long-term surface protection.



Sustainability at Rain Carbon



Rain Carbon's social responsibility approach is built on deep-seated values. Earning the EcoVadis Gold rating the Rain Carbon Germany GmbH has achieved an advanced level of corporate social responsibility. Moreover, Rain Carbon has evaluated the product CO₂ footprints (PCF) of all NOVARES[®] resins which are available for our customers as well. We are continuously seeking for innovative products and optimized production to reduce product carbon footprints (PCF).

Furthermore, Rain Carbon has established the goal of offering sustainable alternatives for NOVARES[®] products and is consistently working to complement its existing product portfolio with sustainable resins. The new products should match the current products in terms of performance and quality. The Introduction of ISCC PLUS certified hydrocarbon resins is one of the first initiatives.

NOVARES[®] eco - The Mass Balance Approach by ISCC Plus Certification

The use of mass balanced ISCC PLUS certified raw material has emerged as a directly implementable option for the production of sustainable hydrocarbon resins. The ISCC PLUS system is an internationally recognized approach and is becoming increasingly established in the food and feed, chemical, pharmaceutical and bioplastic industry.

The NOVARES[®] eco resins form a new line of sustainable ISCC PLUS certified C9, AMS, hydrogenated resins and liquid resins. Mass balancing and allocation to products ensure that an equivalent amount of sustainable raw material is present in the value chain. Taken as a whole, the chemical industry is becoming increasingly sustainable with rising shares of ISCC PLUS certified material. According to the mass balance, the NOVARES[®] eco resins are 100 % ISCC

PLUS certified, making them to sustainable alternatives. The big advantage of the system is that the certified substances do not differ chemically from the known ones. Rain Carbon has already gone through the ISCC PLUS certification process for both production sites in Duisburg and Castrop Rauxel, Germany.

Rain Carbon demonstrates its commitment to environmentally friendly technologies, sustainable products, and the continuous reduction of its carbon footprint. In particular, the company's ISCC PLUS certified NOVARES[®] eco resins meet the requirement of providing sustainable Hydrocarbon resins, that can be easily adapted into existing formulations and compounds.



