

Robust und flexibel –

Non-Isocyanat-Alternativen (NISO) für High Performance

Marco Heuer, Evonik Operations GmbH



Customer requirements for protective coatings

Durable protection for items prone to corrosion

Applicable and curing under ambient conditions

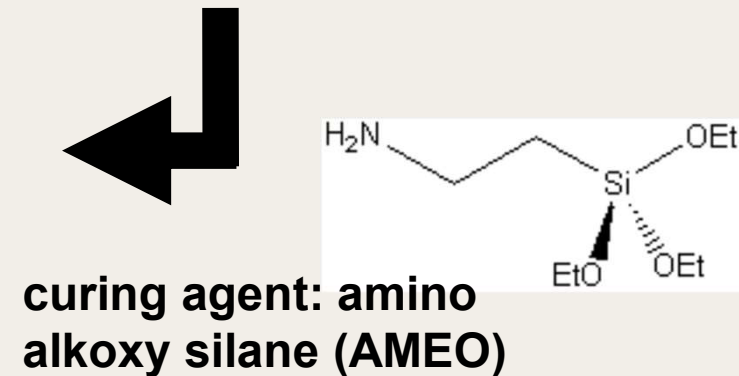
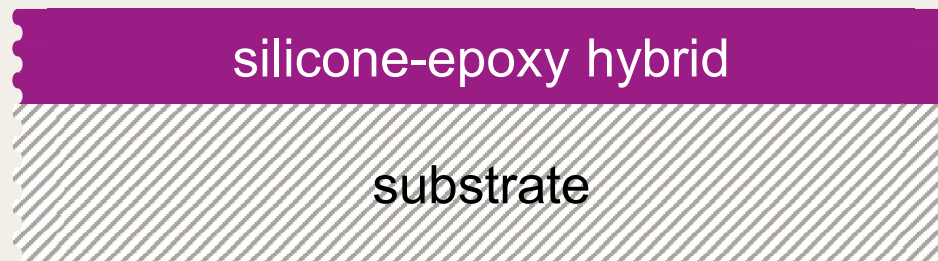
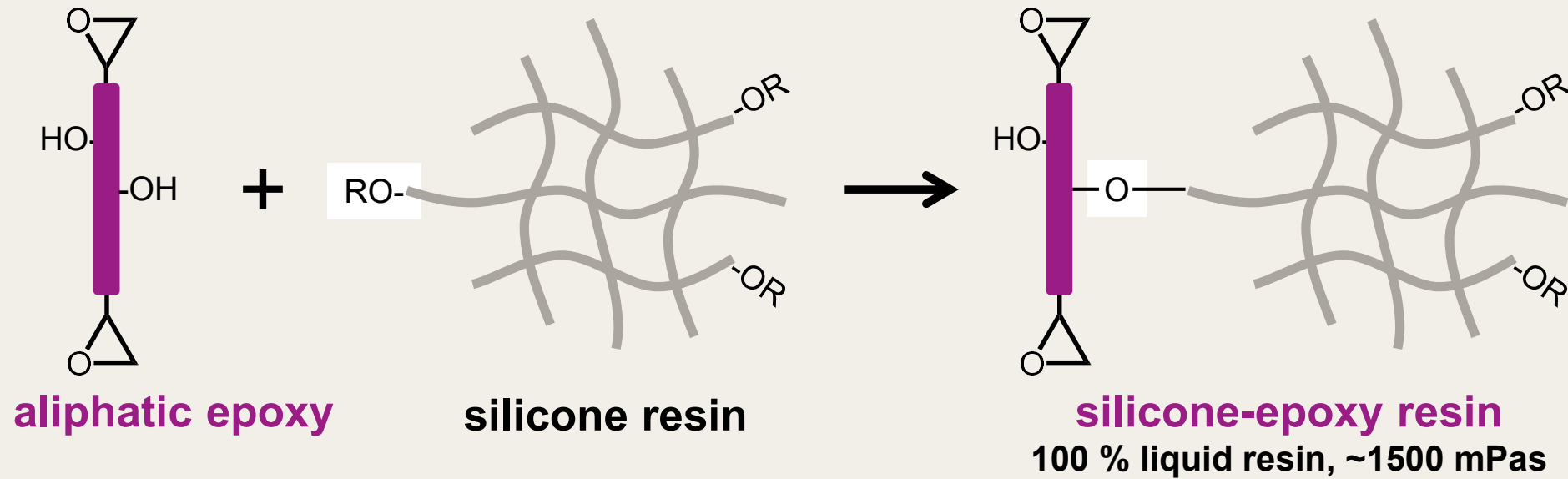
Immunity from mechanical shocks and overcoming elongations



Application areas



SILIKOPON® EF- Silicone-epoxy hybrid NISO technology



SILIKOPON® EF- the best of two worlds



The diagram consists of two rectangular blocks. The left block is purple and labeled 'epoxy part'. The right block is grey and labeled 'silicone resin'. The two blocks are joined at their right and left edges respectively, with a semi-circular protrusion on the purple block fitting into a semi-circular indentation on the grey block, symbolizing a perfect fit or hybridization of the two materials.

epoxy part

silicone resin

Advantages

- good mechanical properties
- corrosion protection
- increased solvent resistance
- high pigment loading capacity

Advantages

- increased heat stability
- good chalk resistance
- increased weather stability
- increased stain resistance

Advantages of hybrid resins versus cold blends

- no phase separation
- no instability that leads to poor weather and chemical resistance

Benefits at a glance

- ultra high solids coatings
- VOC content < 250 g/L clear coat < 100 g/L
- non-isocyanate curing

- good weather resistance
- outstanding chemical resistance
- excellent color and gloss retention

- top coat applications
- curable under ambient conditions



Advantage - bundling of three technologies

Silicone-epoxy hybrid resin - **SILIKOPON® EF**

aliphatic epoxy

- corrosion resistance
- chemical resistance

alkoxy silicone resin

- UV resistance
- low yellowing

hardener

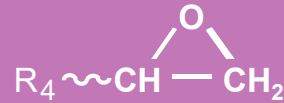
amino alkoxy silane

- corrosion protection
- chemical resistance

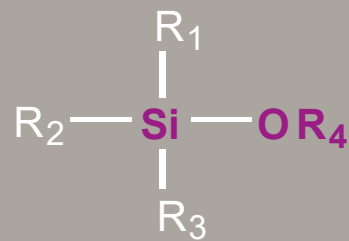
Advantage - bundling of three technologies

Silicone-epoxy hybrid resin - SILIKOPON® EF

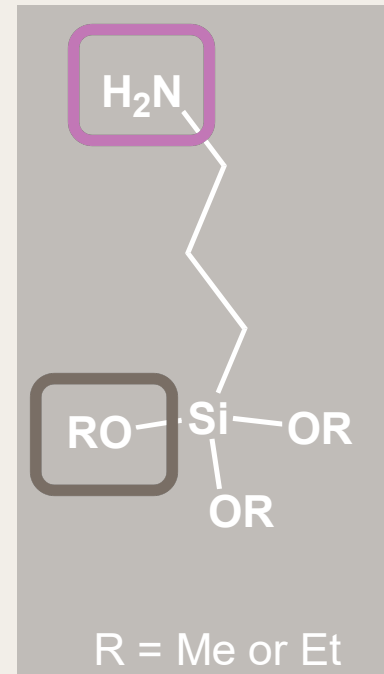
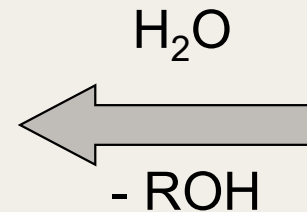
aliphatic epoxy resin



alcoxy silicone resin



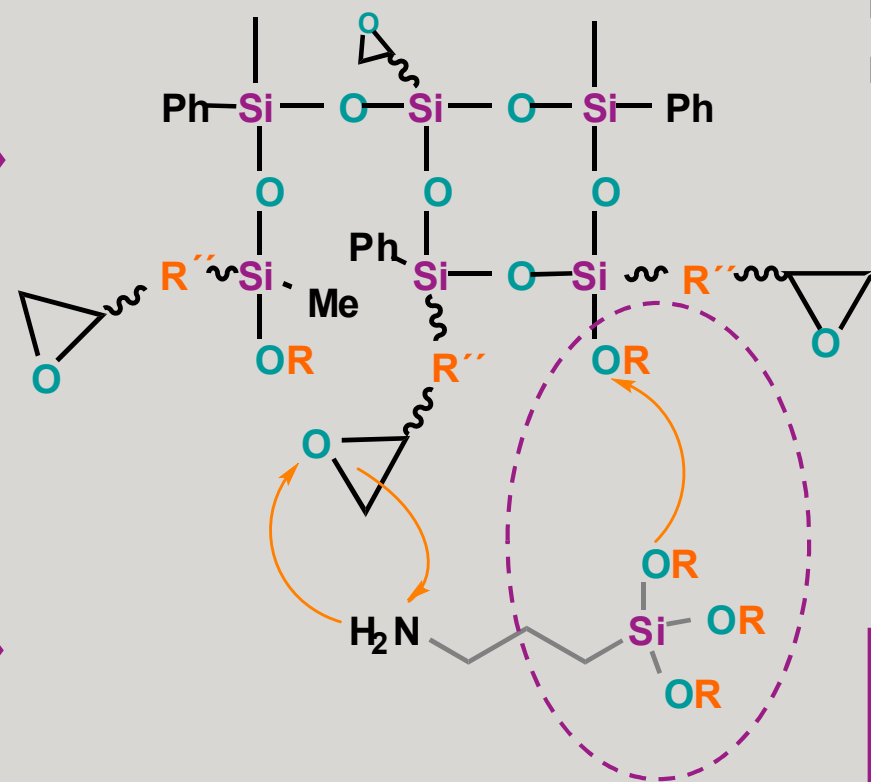
amino alkoxy silane (AMEO)



Chemical cross-linkage

SILIKOPON® EF

silane (AMEO)



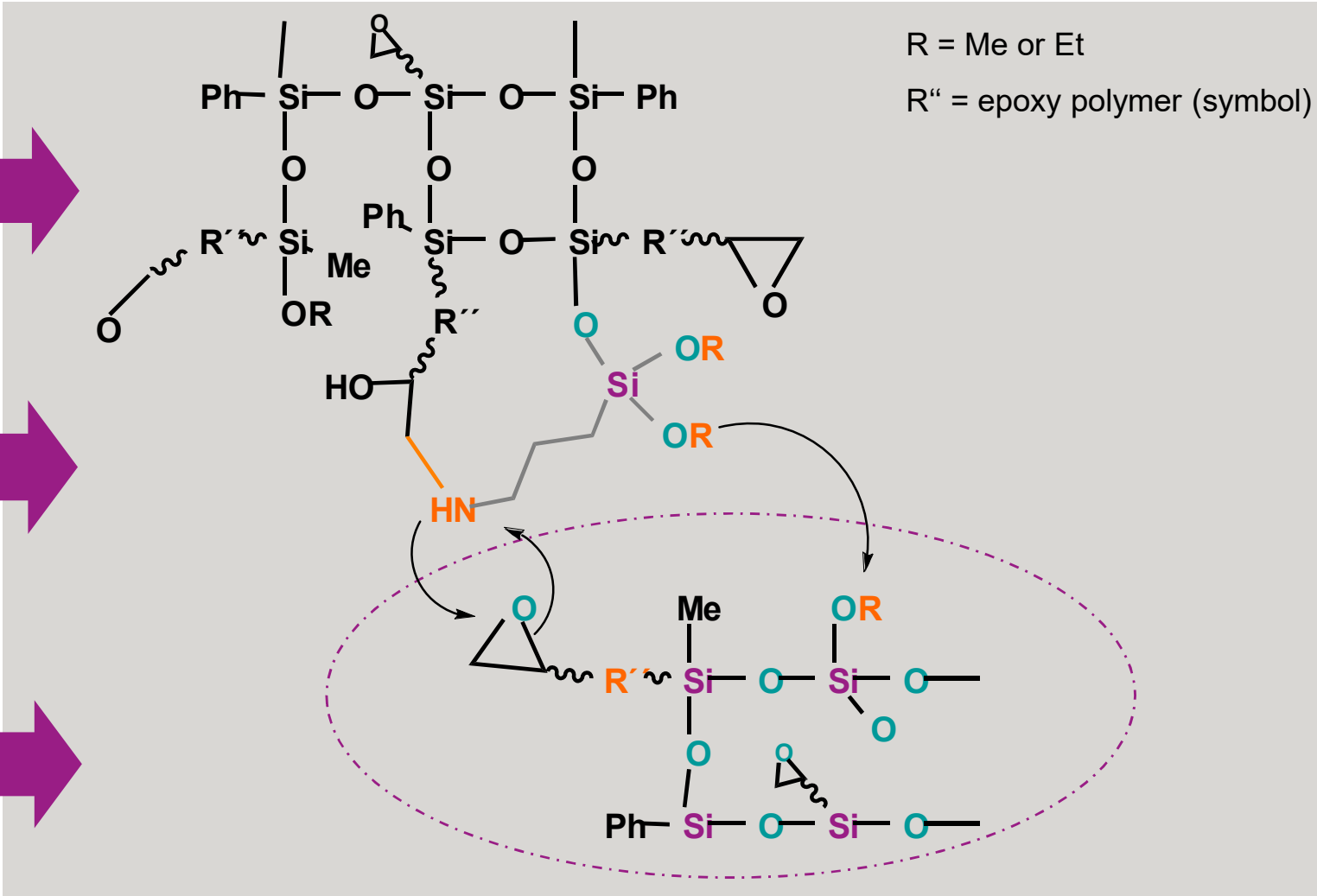
main curing mechanism
hydrolyzation/condensation
of the alcoxy groups
This reaction can be catalyzed.

Chemical cross-linkage

SILIKOPON® EF

silane (AMEO)

SILIKOPON® EF

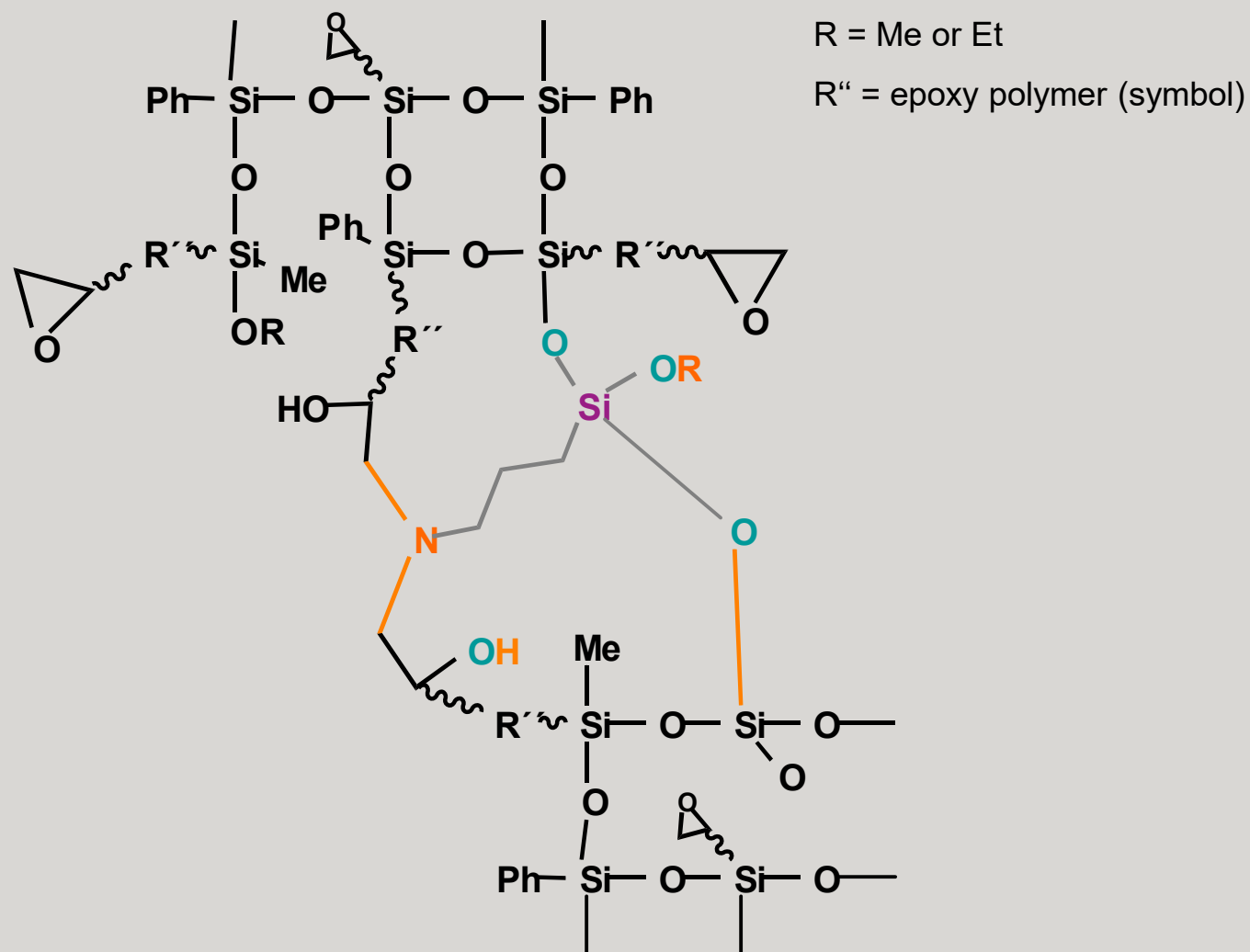


Highly cross linked silicone epoxy

SILIKOPON® EF

silane (AMEO)

SILIKOPON® EF



New flexibilizer

Corrosion- and weather-resistant protective coatings based on silicone-epoxy hybrids tend to become brittle over time. This may lead to cracks caused by mechanical shock. Through these tiny, often-hidden cracks, the corrosion starts to weaken the strength of the protective coatings.

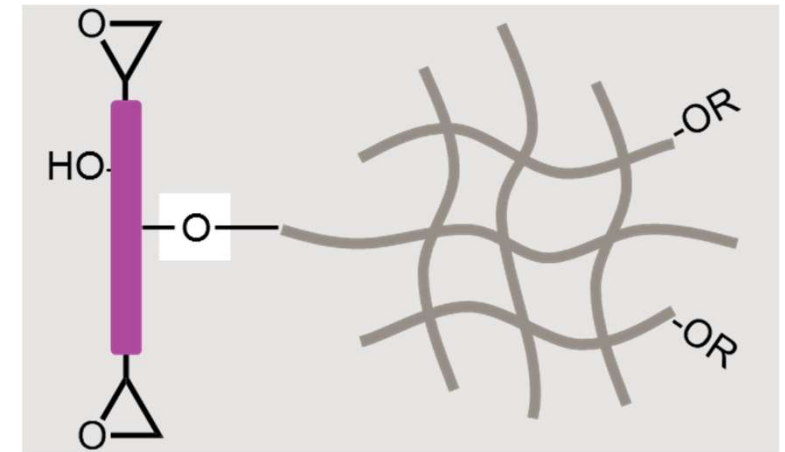
The new flexibilizer **ALBIDUR® 1223** is a solvent-free reactive resin modifier. Being a non-hazardous reactive flexibilizer, it is easy to incorporate, it is very compatible, and it increases the overall robustness of the coating.

- Combines visco-elastic behavior with unchanged protective properties of the final coating
- Reactive groups for crosslinking
- Solvent-free



Data on chemical media

Property	SILIKOPON® EF
Active matter	100%
Viscosity	~1.5 Pas
Density	~1.0 g/ml
Appearance	Clear
Flash point	>100 °C
Combustion point	>150 °C
Degree of crosslinking	High
Silicone content	High
Si-binder compatibility	low
Functionality	12
Flexibility	low



Data on chemical media

Property	ALBIDUR® 1223
Active matter	100%
Viscosity	~35 Pas
Density	~1.0 g/ml
Appearance	Clear
Flash point	>100 °C
Combustion point	>150 °C
Degree of crosslinking	Medium
Silicone content	None
Si-binder compatibility	High
Functionality	6
Flexibility	High



Benefits of silicone-epoxy hybrid technology

- Long-lasting protection of economic goods
- Reduced overall costs
- Future-proof, meets VOC requirements
- Isocyanate-free

Along with the enticing technical properties, silicone-epoxy resins perform very well in the Life Cycle Assessment (Cradle-to-Gate). The influence in global warming, primary energy demand, and photochemical ozone creation potential is comparatively low.

Test in details





Corrosion protection



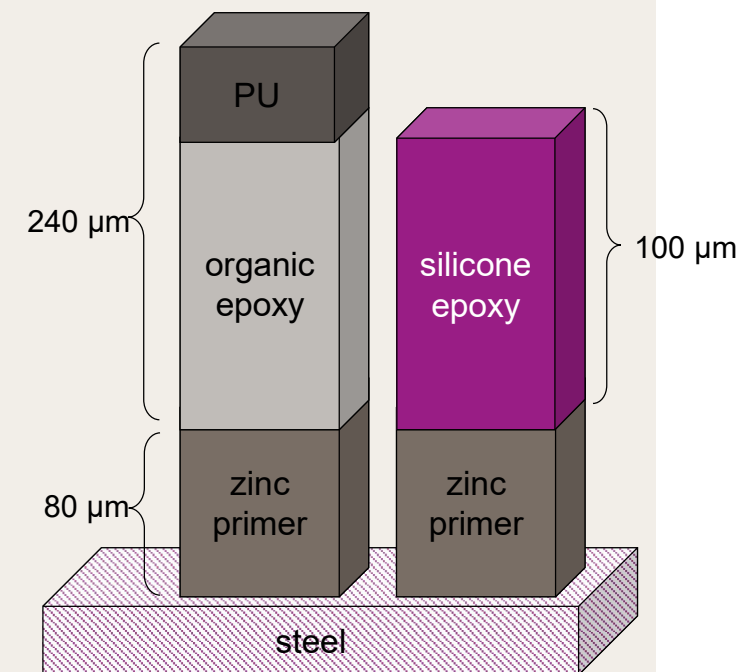
Reference system

Reduction from 3
to 2 coating layers
possible with
SILIKOPON® EF!

– 44% film
thickness



Thin silicone hybrid system





Easy-to-clean effect

Cold blend – 2K PUR

Silicone : Acrylic
30:70

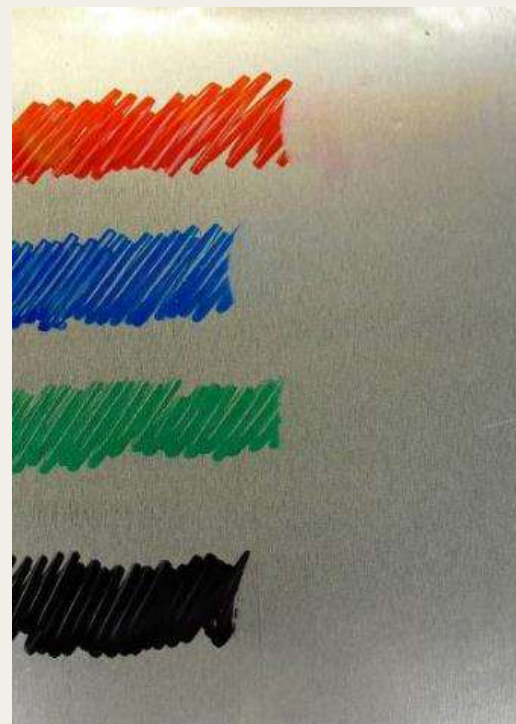


2-pack PUR system

Based on acrylic resin



SILIKOPON® EF with AMEO

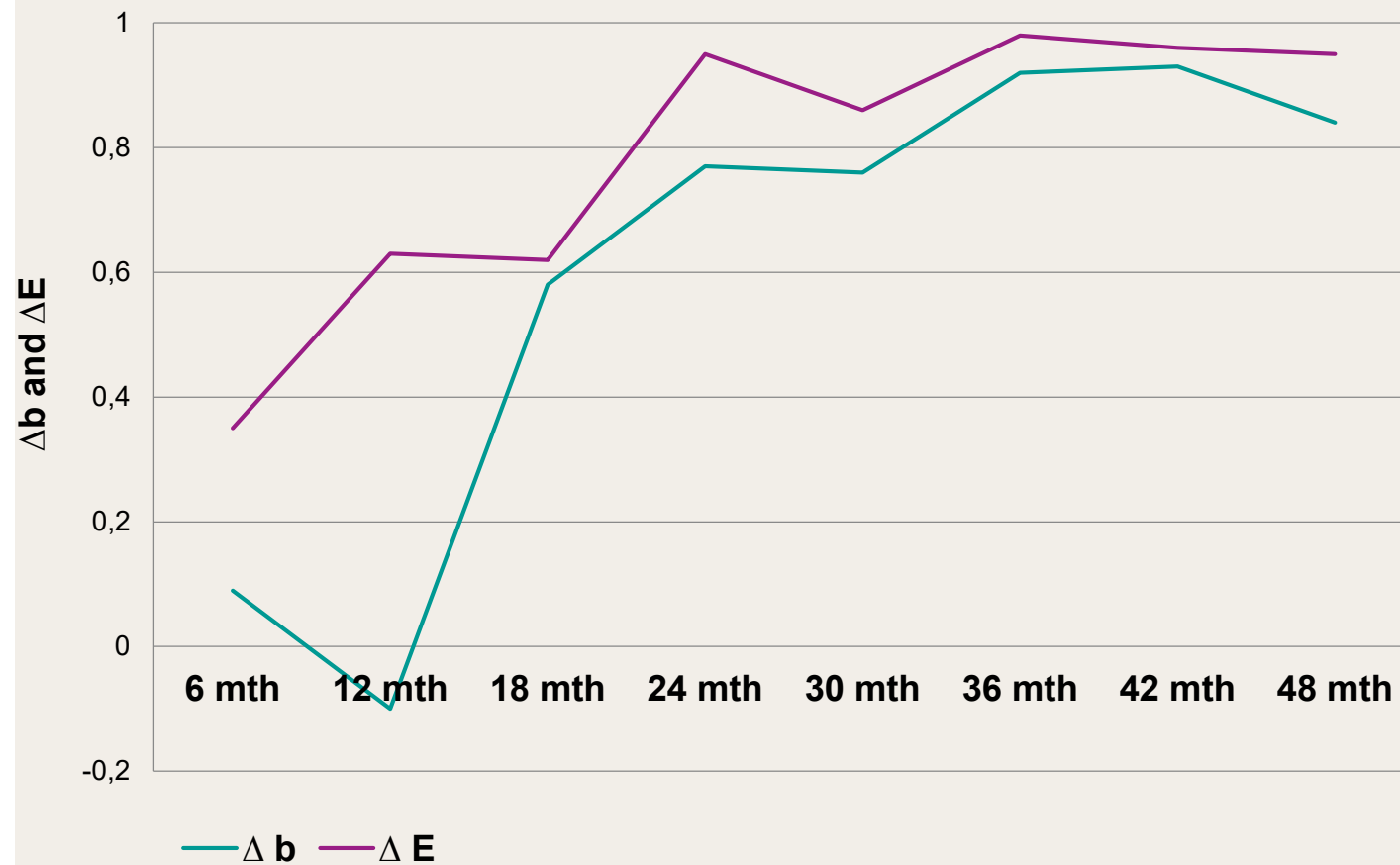


**The easy-to-clean effect
is provided by
SILIKOPON® EF!**

- Painted with different permanent markers, conditioned 7 days at room temperature.
- Cleaned with the anti-graffiti system “AGS 221”.
- Cleaner batched for 3-4 minutes on the surface and wiped off with a soft brush.



Weather Resistance



Outdoor Florida test

- Yellowing (b)
- Color stability (E)

Formulation

Raw material	p.b.w
SILIKOPON® EF	48.8
Light stabilizer	1.2
Titanium dioxide	44.5
Butyl acetate	5.5
Total	100
Hardener	12.2

Curing conditions: 3 hours at 80 °C

Test formulation

Guiding Formulation

GF PON EF 9 009, white, high gloss, flexible

Raw material	p.b.w
SILIKOPON® EF	30.00
Deaerator	1.00
Dispersing Agent	1.00
Rheology modifier	1.00
Titandioxide	30.50
Filler	7.00
xylene	1.00
	71.50
Let-down	
Silicone-epoxy Resin	20.00
Flexibilizer	5.00
Light stabilizer	0.50
Light stabilizer	1.00
n-butylacetate	2.00
total	100.0

Coating properties (without hardener)

Theoretical solids content	~ 95 %
Coating density	1.47 g/cm³
VOC (calculated)	~ 75 g/l

Mixing ratio (95% cross linking)

Hardener mixture

AMEO : JEFFAMINE® D 230 = 6.9 : 1.0

Coating system

coating : hardener mixture = 100 : 10.4

Catalyst TIB KAT® 318
(on binder solids)

= 1.0 %

**5% of SILIKOPON® EF was exchanged for
ALBIDUR® 1223 in the formulation GF PON 9 004**



Technical properties



Drying time



Corrosion protection



Weather resistance



Adhesion



Flexibility

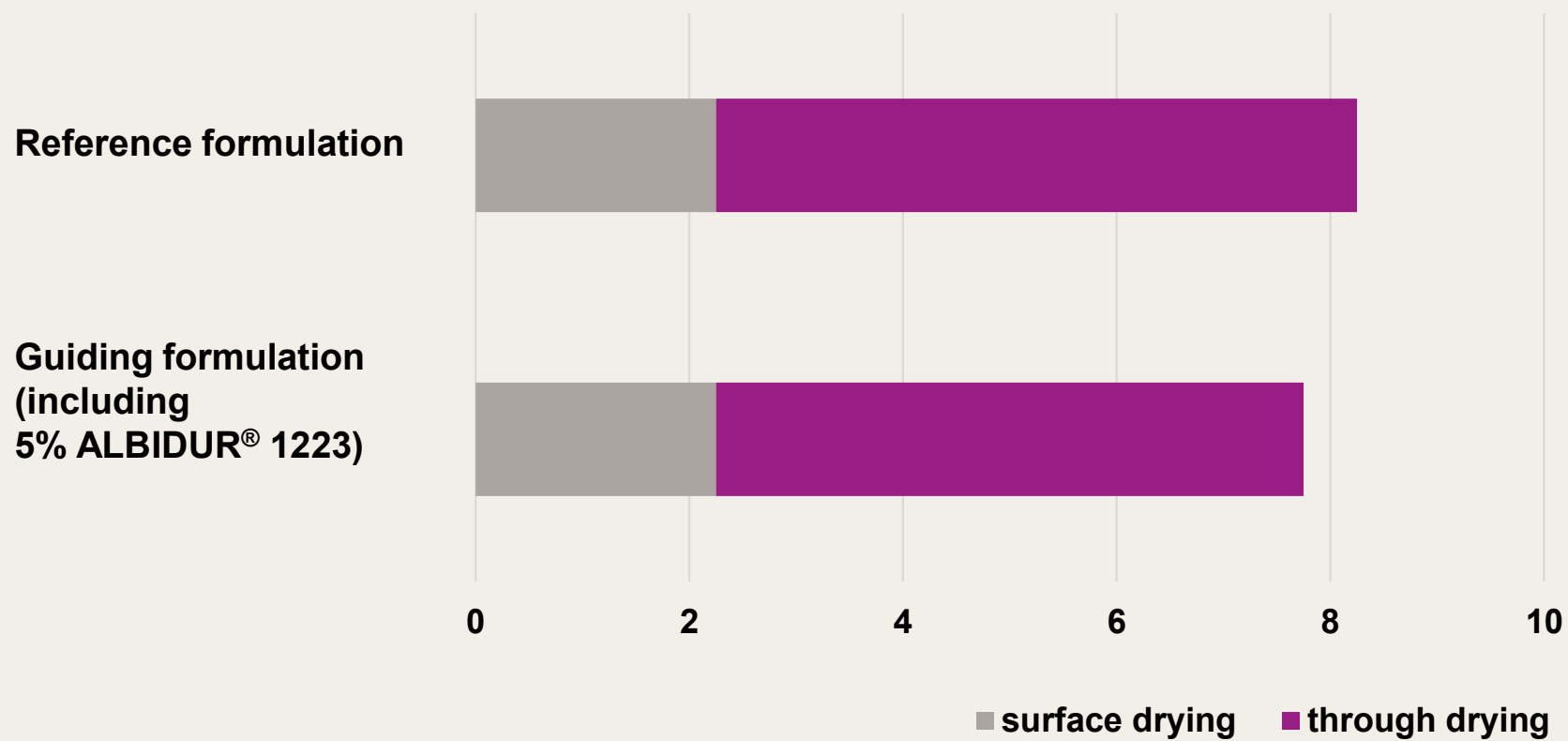


Chemical resistance





Drying time



Reduction in drying time

Measured with drying recorder
at room temperature

DFT: ~80µm



Corrosion protection

Adhesion under severe conditions

The high crosslinking present in chemical-resistant binder systems often impairs the overall corrosion protection, and the coating may become brittle. This can lead to cracks that occur through daily wear and tear, such as mechanical shocks or elongation due to temperature changes.

Using the **ALBIDUR® 1223** as co-binder in ultra-high solid coatings helps to avoid corrosion by preventing cracking over time.

Test in details





Corrosion protection

ALBIDUR® 1223 maintains corrosion protection!



Corrosion after salt spray test
according to DIN ISO EN 9227

Both formulations tested
(with/without **ALBIDUR® 1223**)
on shot-blasted steel panels

**Test results after
720 h exposure:**

Delamination: 1.0 mm

Degree of blisters: 0

Degree of rust: Ri 0



Weather resistance

Protection against solar radiation

To maintain quality of protective coatings all components have to prevent damages and peeling – even under the toughest weather conditions.

ALBIDUR® 1223 as co-binder is stable to solar radiation. The final coatings achieve stable color and gloss.

Test in details 





Weather resistance



- QUV- A weathering
- According to ASTM G154 Cycle 1



Adhesion

Excellent adhesion

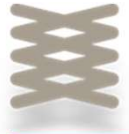
To improve adhesion on metals and concrete, protective coatings require high-performance binders.

ALBIDUR® 1223 protects coatings from damages caused by external impacts

- Crosslinked with the binder system
- Excellent compatibility with silicone binders
- Cross-cut is unchanged at the highest stage

With the addition of ALBIDUR® 1223, the formulation becomes more robust while the adhesion is unchanged on the highest level.





Flexibility

Improved flexibility

Industrial coatings are often susceptible to strikes, leading to deformation. Therefore, formulators must ensure that the substrate is protected by the coating.

ALBIDUR® 1223 shows excellent elasticity that results in superior deformability and impact resistance. These characteristics lead to better tough elasticity and adhesion on diverse materials.

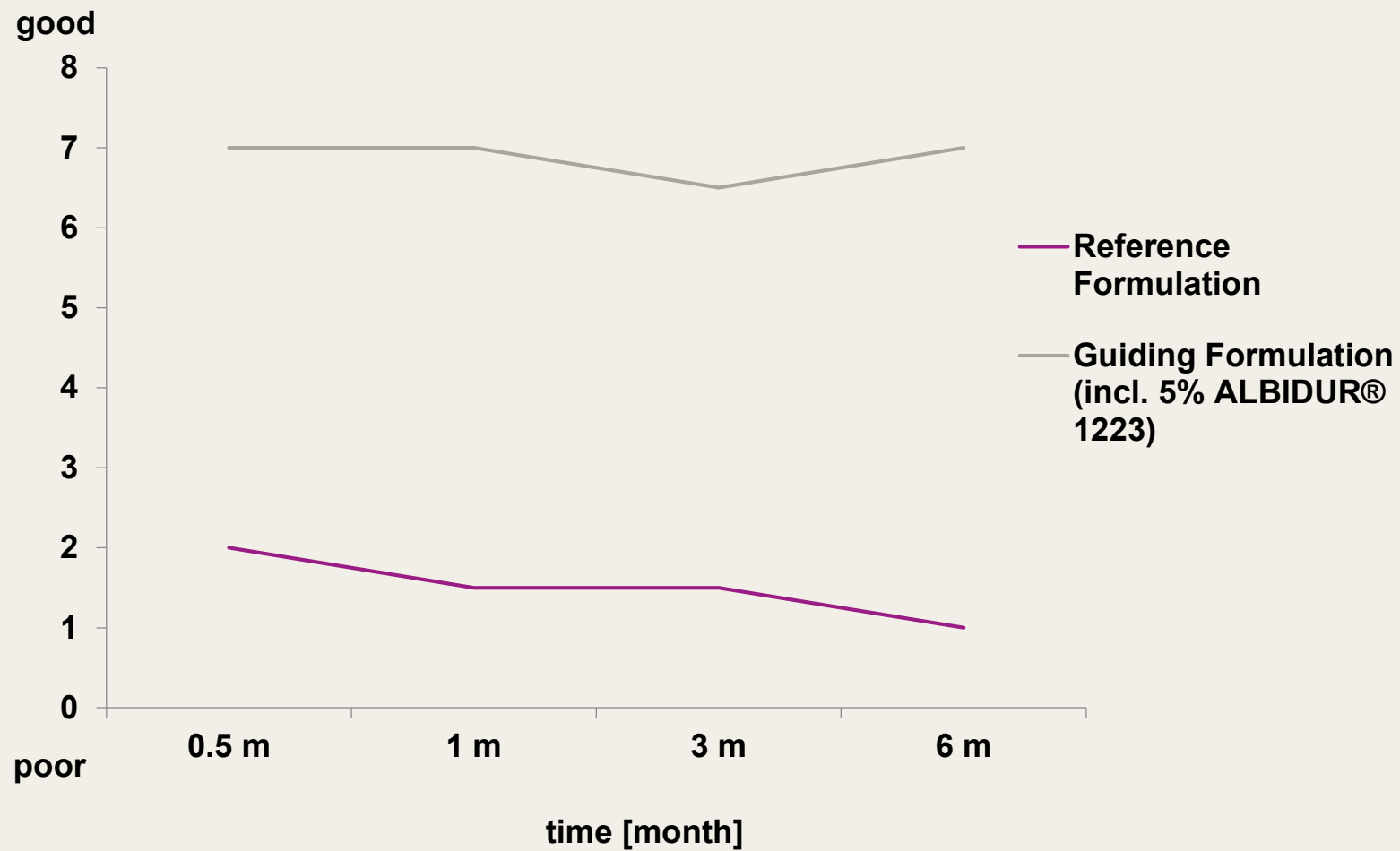


Test in details





Flexibility



Erichsen ranking:

0 – bad = 38.1 mm Ø

8 – good = 3.2 mm Ø

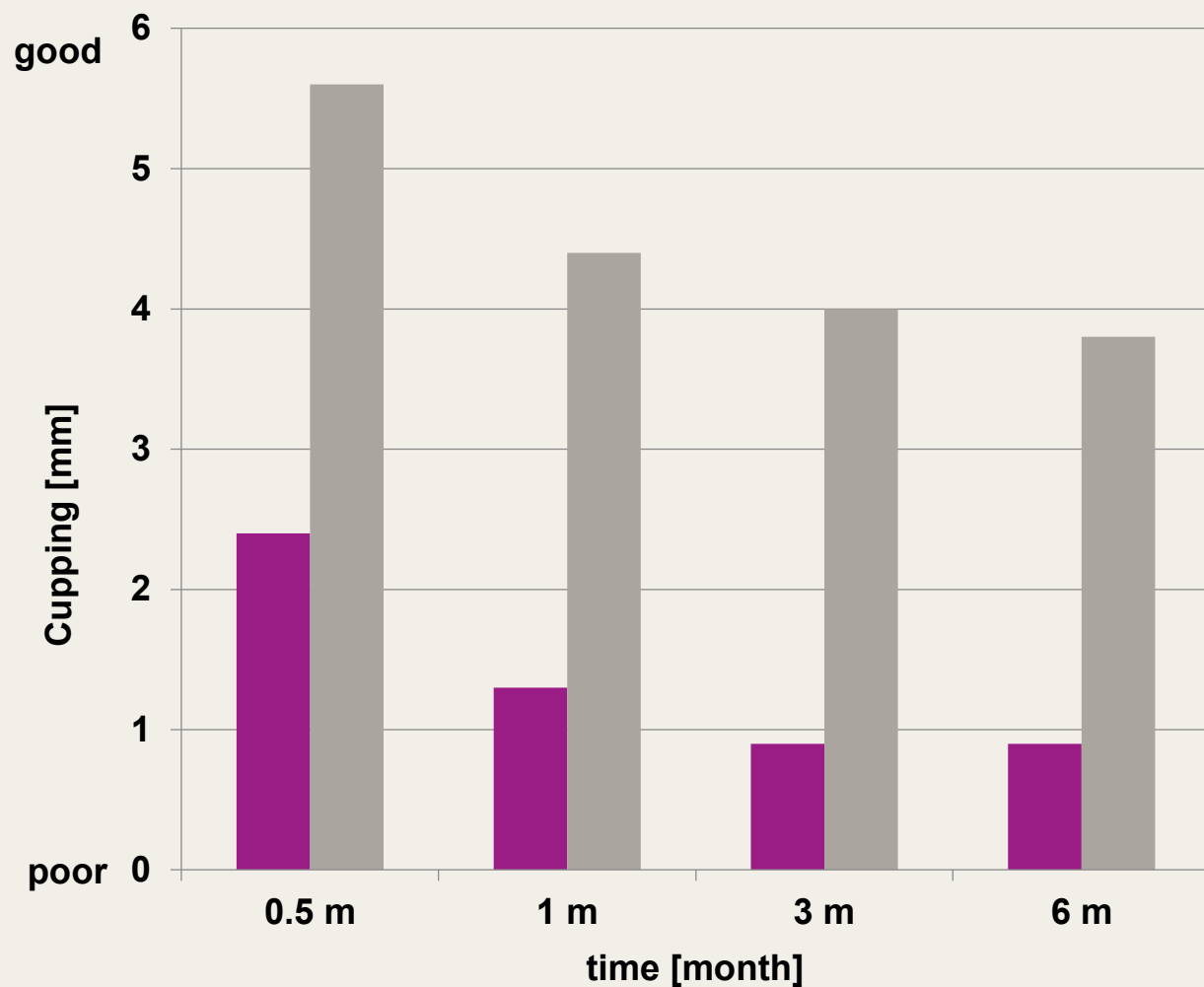
Conical mandrel according to
DIN EN ISO 6860

Curing at room temperature

DFT: ~80µm



Flexibility



■ Reference Formulation

■ Guiding Formulation
(incl. 5% ALBIDUR®
1223)

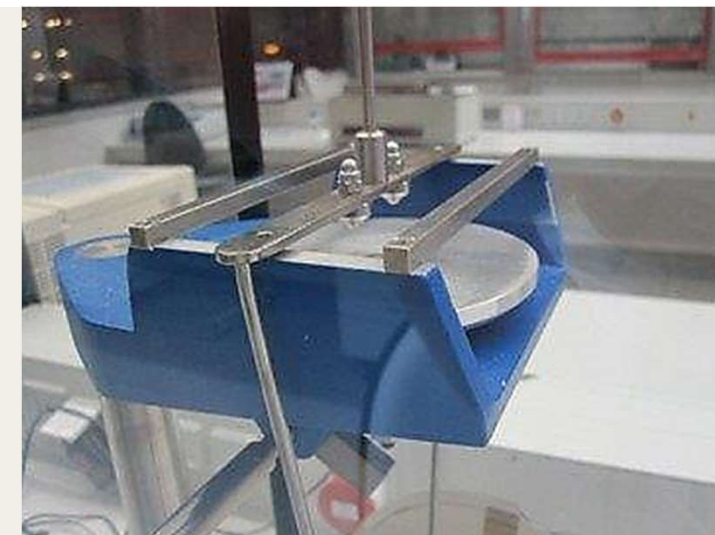
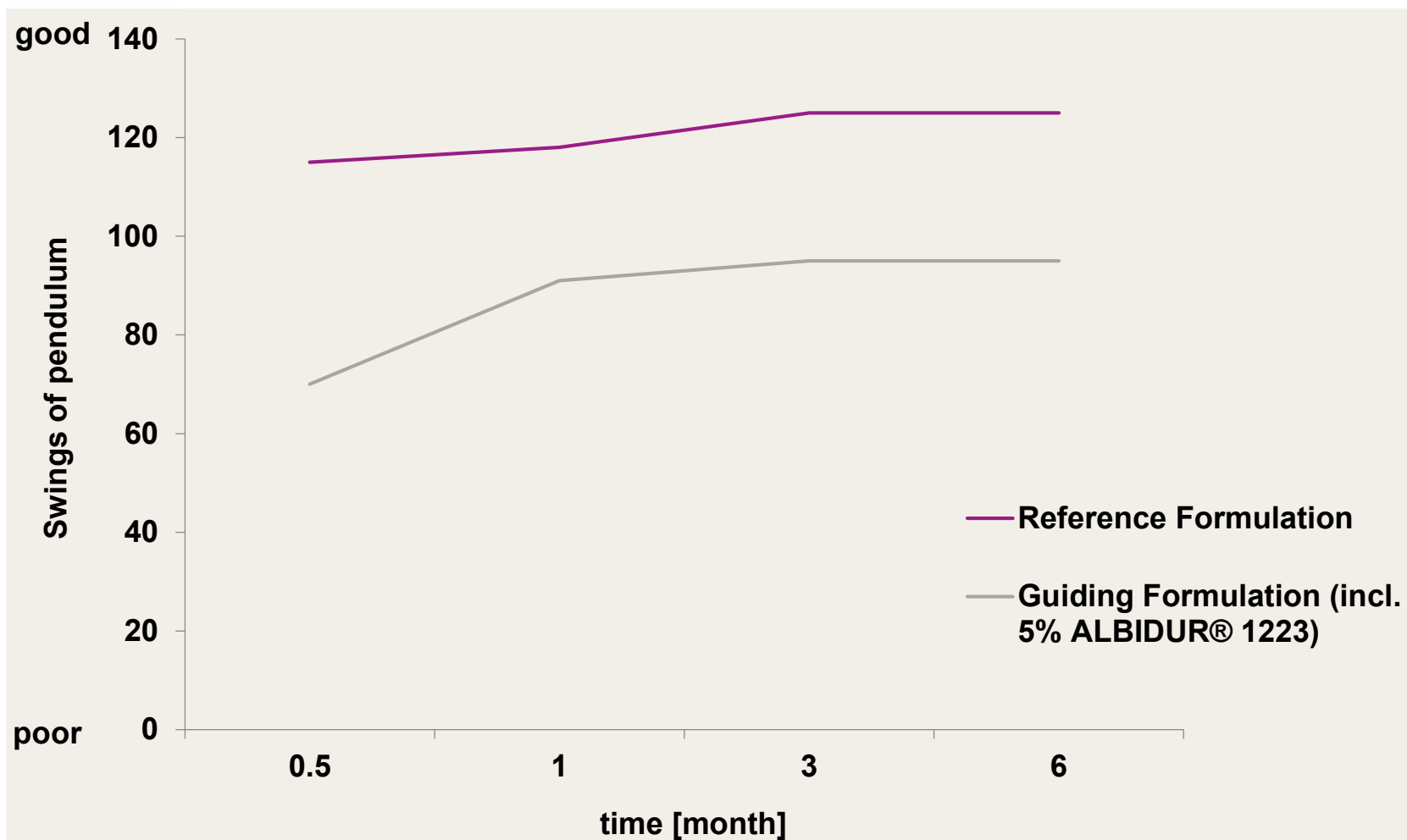


Erichsen cupping according to
DIN EN ISO 20482

Curing at room temperature
DFT: ~80µm



Influence on surface hardness



Pendulum Hardness in accordance with König, conforming to DIN 53157

Curing at room temperature

DFT: ~80µm



Chemical resistance

Aging of test panels	14 d	1 m	3 m	6 m
Reference formulation	●	●	●	●
Guiding formulation (incl. 5% ALBIDUR® 1223)	●	●	●	●

The chemical resistance is unchanged while the overall robustness of the coating is improved!

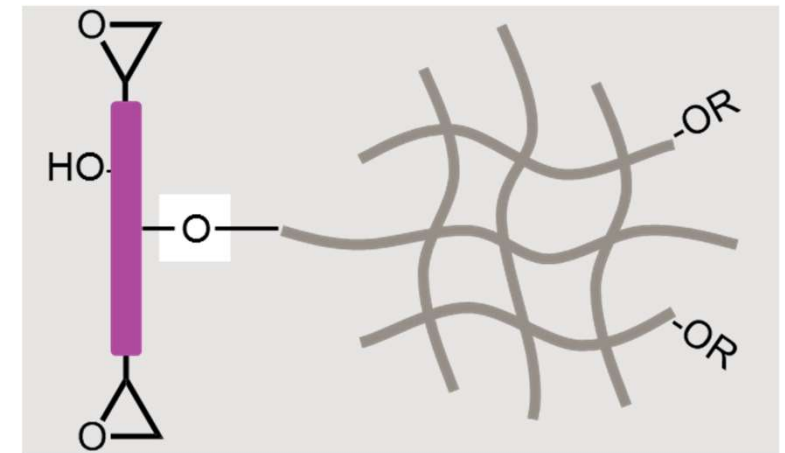


According to DIN EN ISO 2812-4 for 8 hours

- = **fully resistant against:**
 - ✓ Sulfuric acid (50%)
 - ✓ Sodium hydroxide (20%)
 - ✓ Hydraulic oil fluid

Data on chemical media

Property	SILIKOPON® EF
Active matter	100%
Viscosity	~1.5 Pas
Density	~1.0 g/ml
Appearance	Clear
Flash point	>100 °C
Combustion point	>150 °C
Degree of crosslinking	High
Silicone content	High
Si-binder compatibility	low
Functionality	12
Flexibility	low



Data on chemical media

Property	ALBIDUR® 1223
Active matter	100%
Viscosity	~35 Pas
Density	~1.0 g/ml
Appearance	Clear
Flash point	>100 °C
Combustion point	>150 °C
Degree of crosslinking	Medium
Silicone content	None
Si-binder compatibility	High
Functionality	6
Flexibility	High



At a glance



**Anti-corrosion
coatings**

**Long-lasting flexibility leads to permanent
protection of sensitive substrates**



**Technical
properties**

**Achieve outstanding levels of chemical and
weather resistance**



**Product
properties**

**Worldwide registration and 100% solid content
simplify logistics and transportation**

Your Contact for more information



Technical Support

Marco Heuer

Phone +49 201 173-3995

marco.heuer@evonik.com

