Bio-based dual cure binders

For high quality solvent-based and solvent-free paints, wood oils and clear coats

Lars Ossenschmidt

Dr. Anke Wiegand

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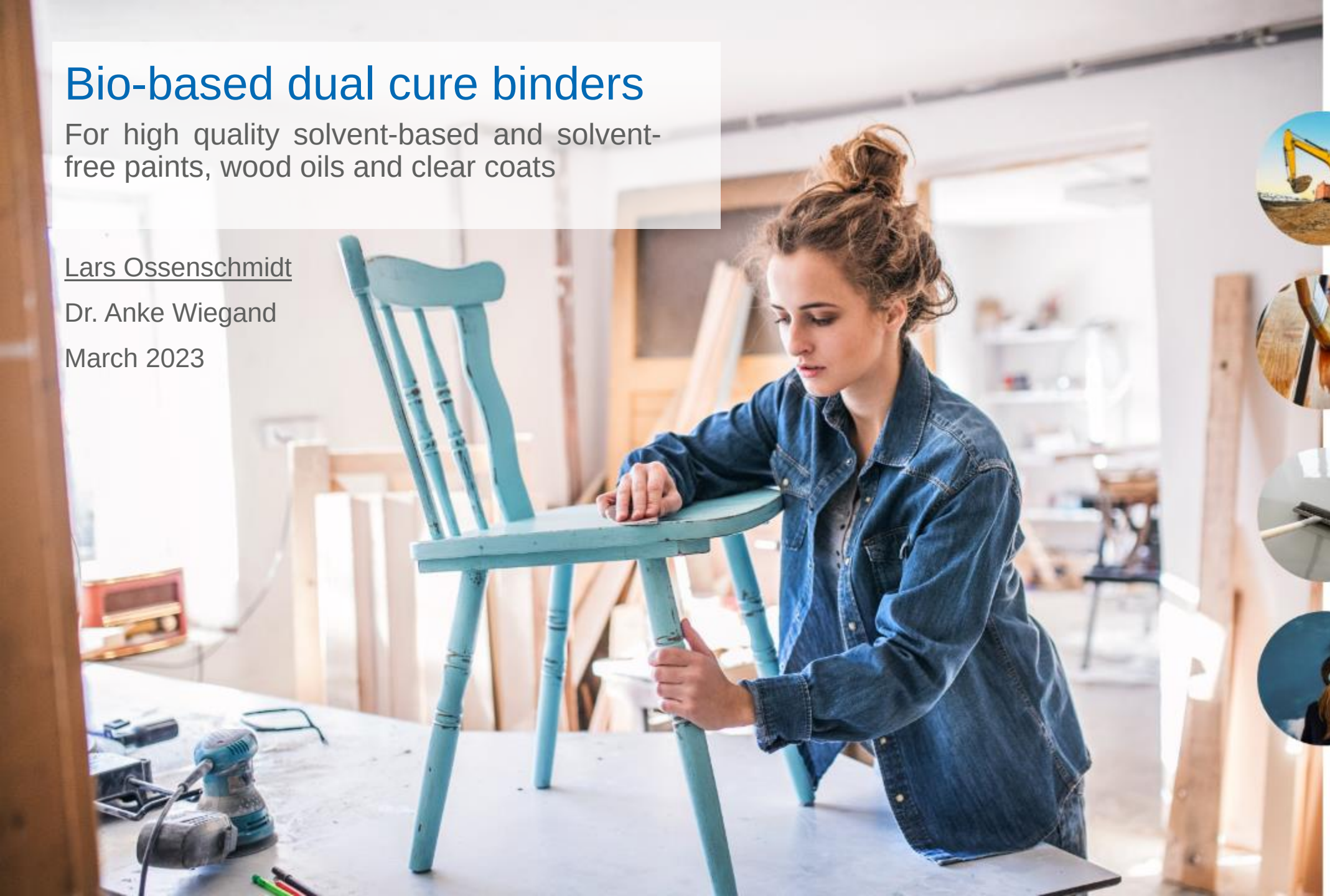

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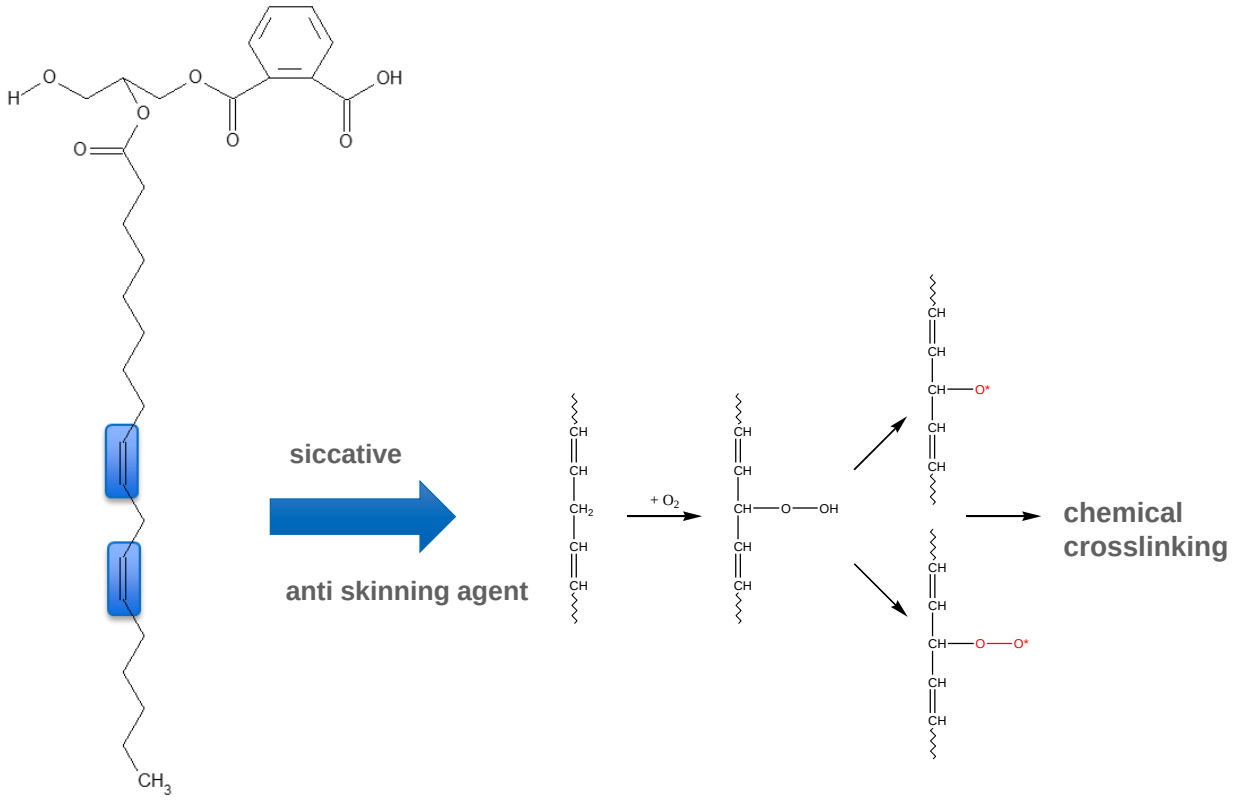
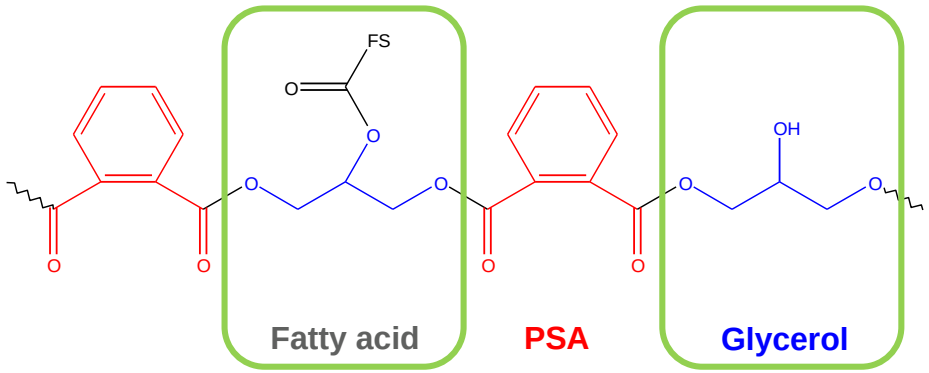
Background to the development of the technology

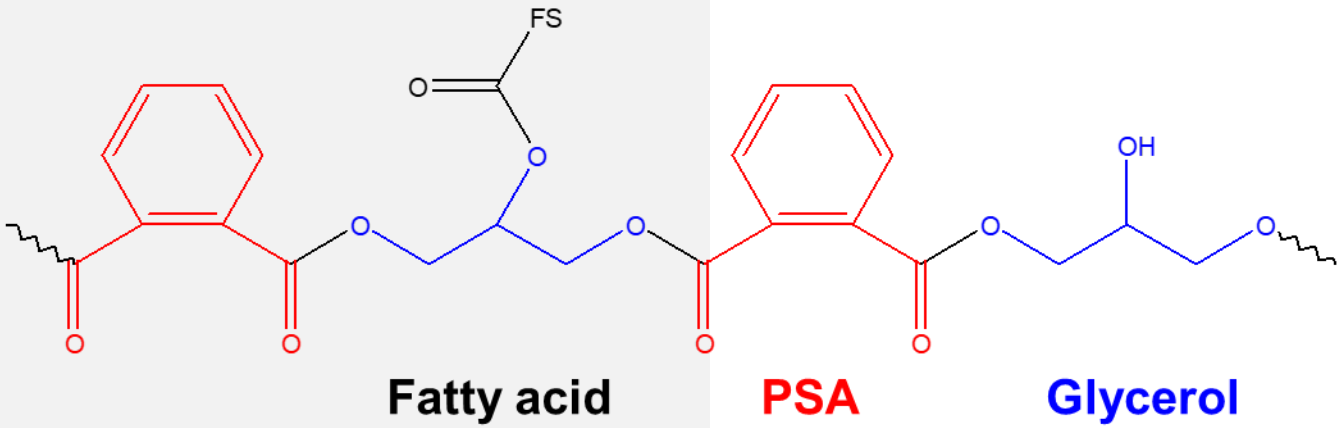
Alkyd resins are versatile products based on a high content of bio-based raw materials.





Alkyd resins are reaction products of polyfunctional alcohols, polyfunctional carboxylic acids and vegetable fatty acids. Today, they can already be made from more than 85% bio-based raw materials.

Alkyd resins offer advantages but also challenges in architectural coatings.



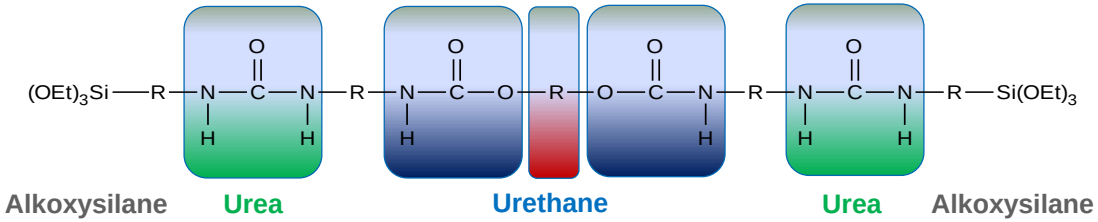
Challenges

- Drying properties are extremly influenced by
  - ❖ molecular weight
  - ❖ siccative selection
  - ❖ anti skinning agent
- yellowing of white coatings
- typical smell while drying (aldehydes)

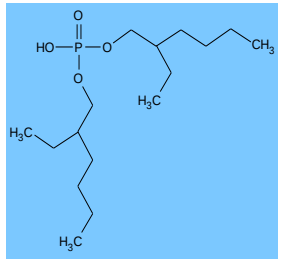
Advantages

- high bio-based content
- infinite pot life
- application properties
- wood warming
- penetration

The products of the WorléePur Si range combine different technologies.



Acid catalyst

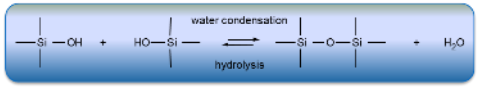


Chemical crosslinking

- **Hydrolysis**

- **Polycondensation**
- Condensation with alcohol (Si-OH > H_2O)

- Condensation with water (H_2O > Si-OH)

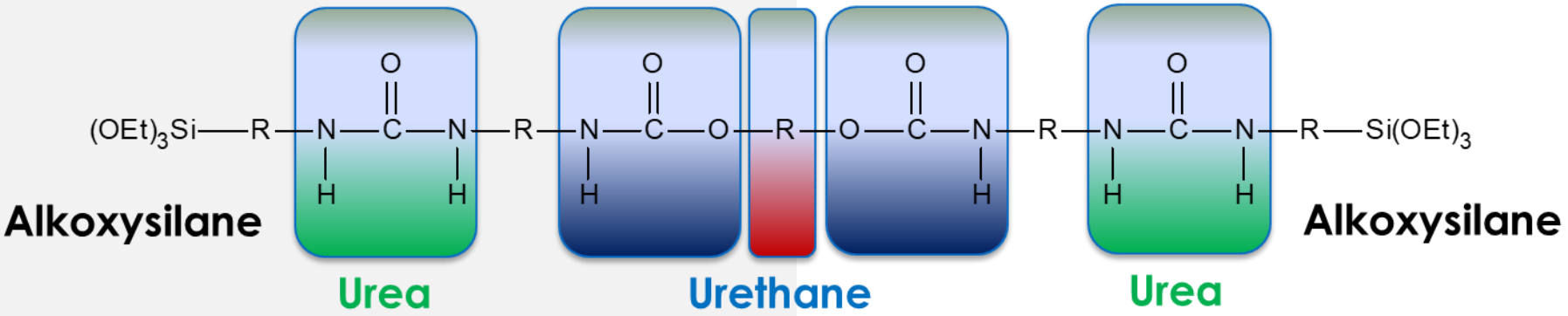


Basic polyol

- Polyester
- Polycaprolactone
- Polycarbonatdiole
- Polyether
- Polyacrylate

The products of the WorléePur Si series are block copolymers with urethane, urea and silane groups. The silane groups crosslink according to the sol/gel process under the influence of moisture.
Depending on the polyol selected, the product contains only small quantities of bio-based raw materials.

Silane functional binders offer advantages but also challenges in architectural coatings.



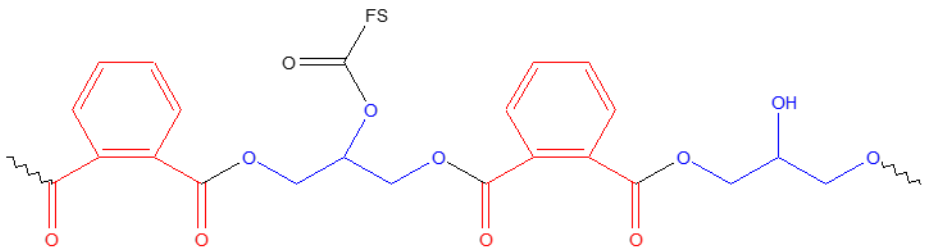
Challenges

- it‘s a 2 K system
- low bio-based content
- application by brush and levelling of the coating
- EU VOC regislation categorie A/d and A/e

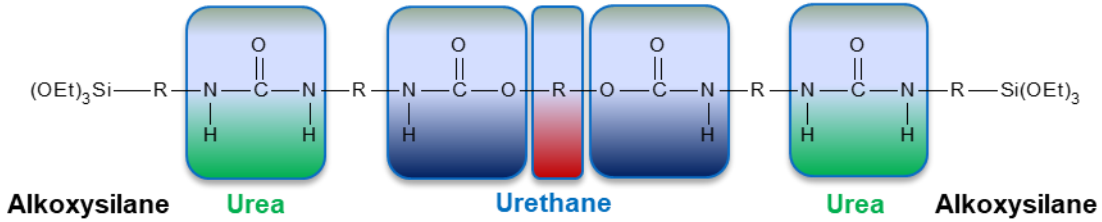
Advantages

- fast drying
- fast cross-linking
- hardness development
- early chemical and mechanical resistance
- low yellowing

The basic idea was to combine the positive characteristics of both technologies.



Fatty acid PSA Glycerol



Alkoxysilane Urea Urethane Urea Alkoxysilane

Advantages

- high bio-based content
- infinite pot life
- application properties
- wood warming
- penetration

Advantages

- fast drying
- fast cross-linking
- hardness development
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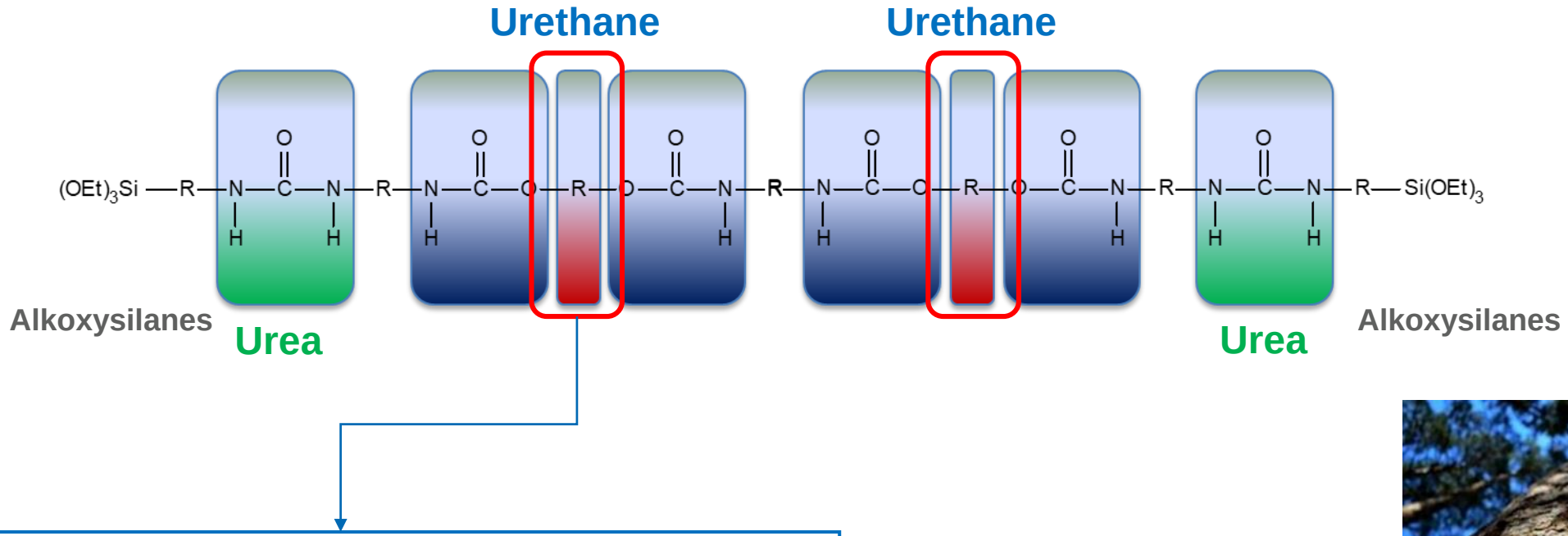
- low yellowing

Chemical structure, cross-linking and possibilities

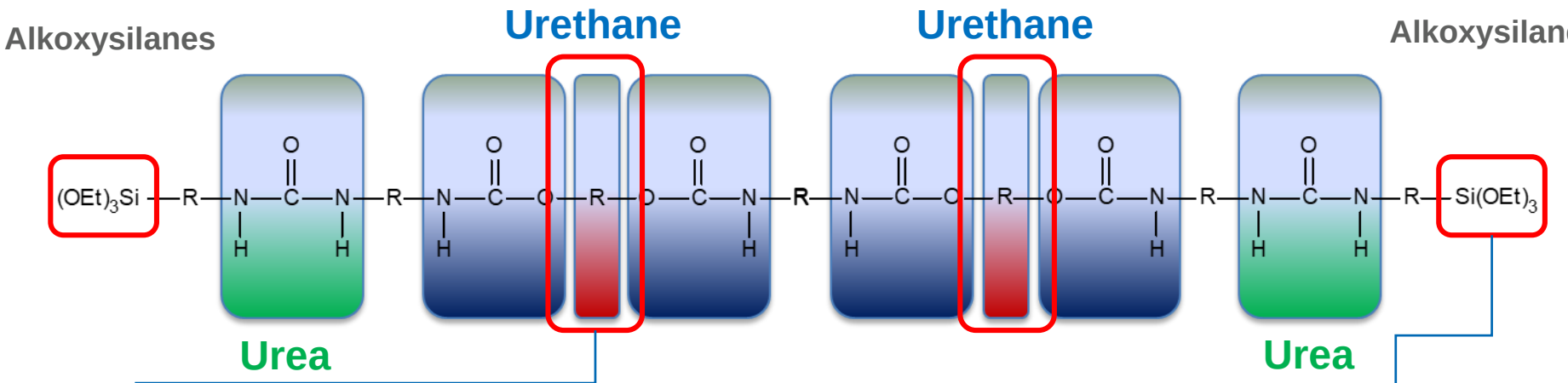
The urethane groups are formed from a bio-based polyol.



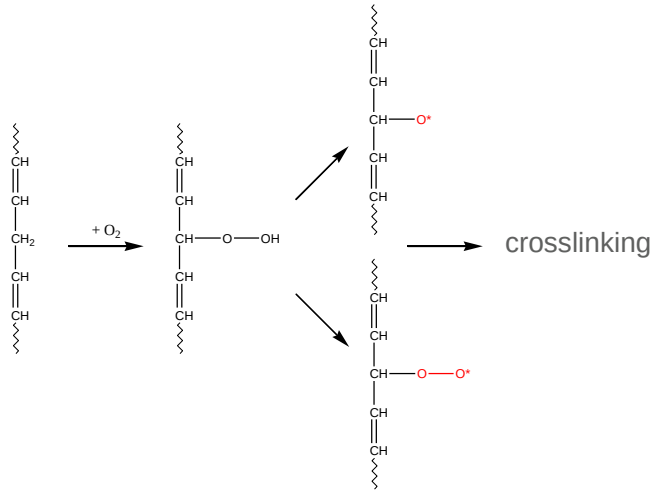
100% bio-based polyol on the basis of tall oil fatty acid

Tall oil fatty acid is a by-product of pulp / paper production, does not compete with food and does not consume any additional arable land.

The binder dries oxidatively and additionally moisture cures.



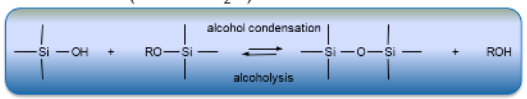
Oxidative drying via the double bonds of the vegetable fatty acids of the base polyol



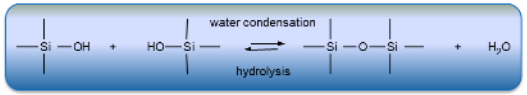
Hydrolysis and polycondensation of the ethoxysilane groups

- **Hydrolysis**

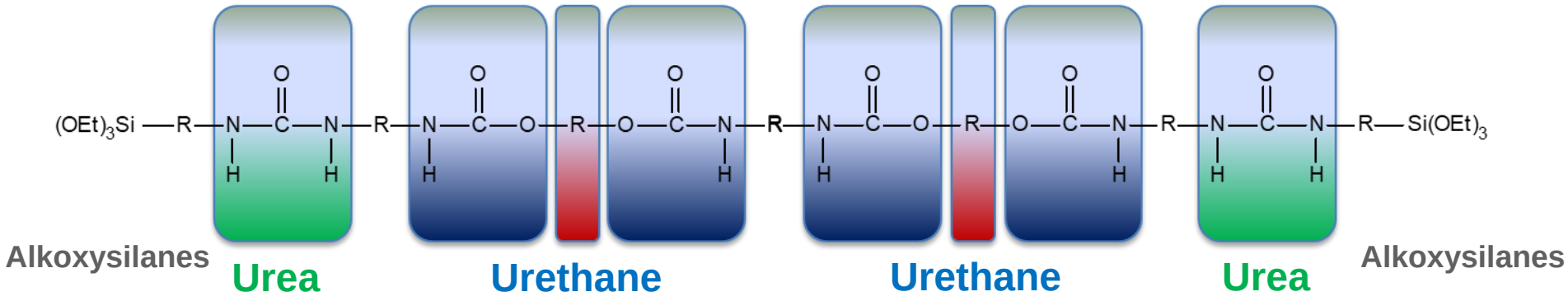
- **Polycondensation**
- Condensation with alcohol (Si-OH > H_2O)



- Condensation with water (H_2O > Si-OH)



Currently, one prototype with a high bio-based content is available – a VOC free type on request.



Name	WorléePur VP Si 1031 T
Binder type	Silane-functional polyurethane-urea binder on the basis of a bio-based polyol
Bio-based content	**78% on solid resin content**
Delivery form	85% Shellsol D60 / Dowanol DPM
Cross-linking	moisture curing via the silane groups oxidative drying via the vegetable fatty acid
Catalyst	Siccative
Processing time	Infinite / 1 K System

Some properties in coating formulations

Coatings based on the technology contain common coating raw materials.

Guide recipe 1.9996 - 28

1K silk gloss lacquer

chemically resistant, oxidative drying, moisture curing

Pos.	Product	Release form	%
1	**Bio-based dual cure binder**	85 % in dearomat. HC 180-220/ Dowanol DPM	26.60
2	Thixotropic binder	60 % in dearomat. HC 180-220	3.00
3	Thermoplastic acrylic	50 % in dearomat. HC 160-200	10.00
4	Dispersing agent		0.50
5	Optical brightener		0.05
6	Titanium dioxide		28.00
7	Dolomit filler		11.00
8	Silica matting agent		3.00
9	Reactive thinner		6.00
10	Silicone additive		0.20
11	Manganese siccative		0.60
12	Aluminium siccative		0.35
13	Zirconium siccative		0.25
14	Calcium siccative		0.35
15	Dearomatized HC 160-200		6.60
16	Dripropylenglykolether		2.50
17	Pentanonoxim		0.50
18	Propylen glycole		0.50
	Total		**100.00**

A combination of the bio-based dual cure binder, a very hard acrylate and a thixotropic alkyd resin forms the basis for the coating.

Reactive thinners can be used and reduce the viscosity.

Apart from siccatives, no other catalysts are required. The quantities added are usually lower than for alkyd resins.

The VOC-compliant varnish achieves good drying and early resistance.

Guide recipe 1.9996 - 28

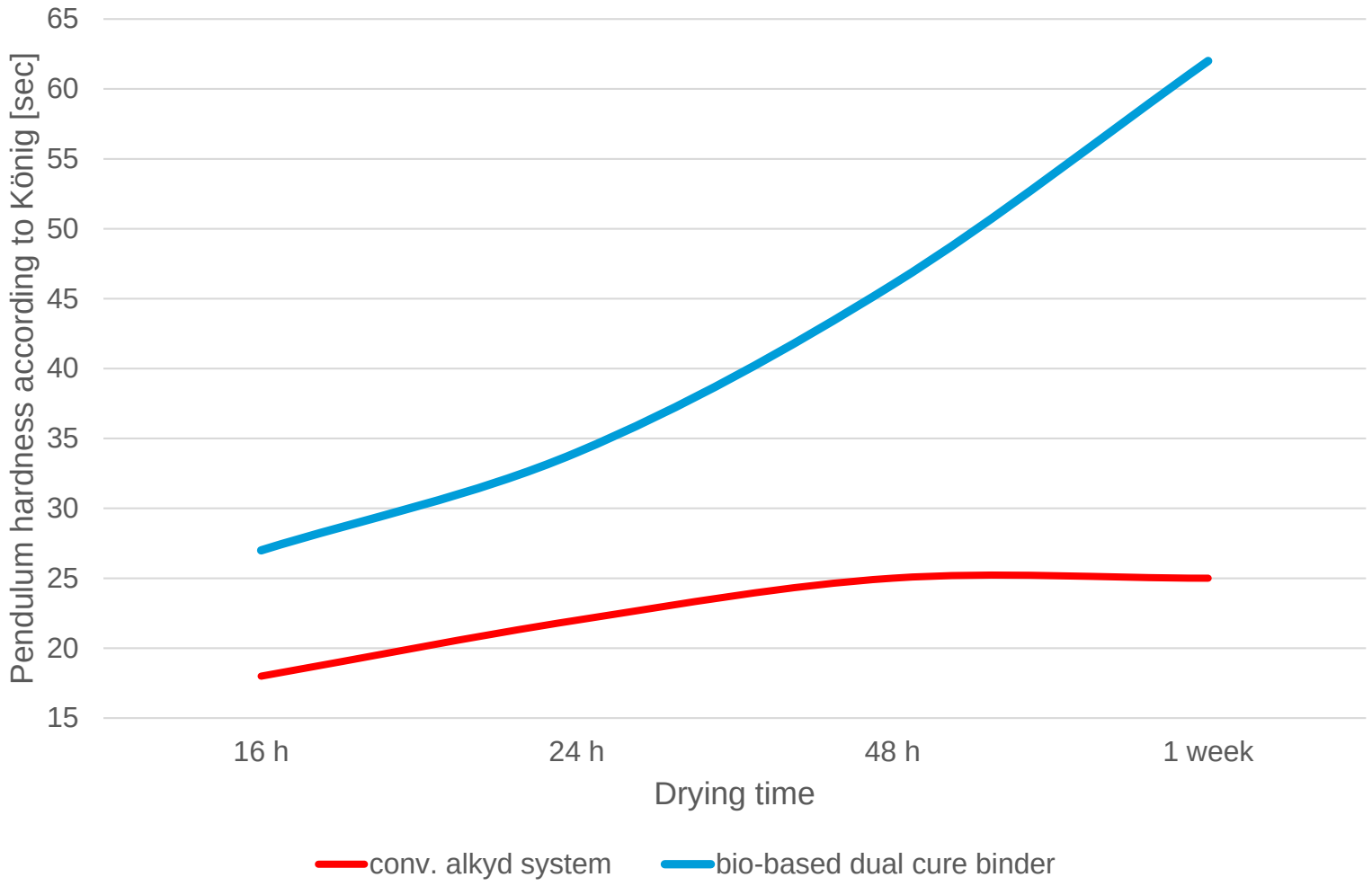
1K silk gloss lacquer

chemically resistant, oxidative drying, moisture curing

Property	
Non-volatile content incl. reactive diluent	78,50%
Density, 20°C	1.33 g/cm³
VOC content	286 g/l
Drying 100 µm wet film on glass	
Dust dry	1 h 30 min
Tack free	5 h 30 min
Drying stage 4	5 h 30 min
Drying stage 6	6 h
MEK resistance	
after 24 h	> 200 double strokes
after 1 week	> 200 double strokes

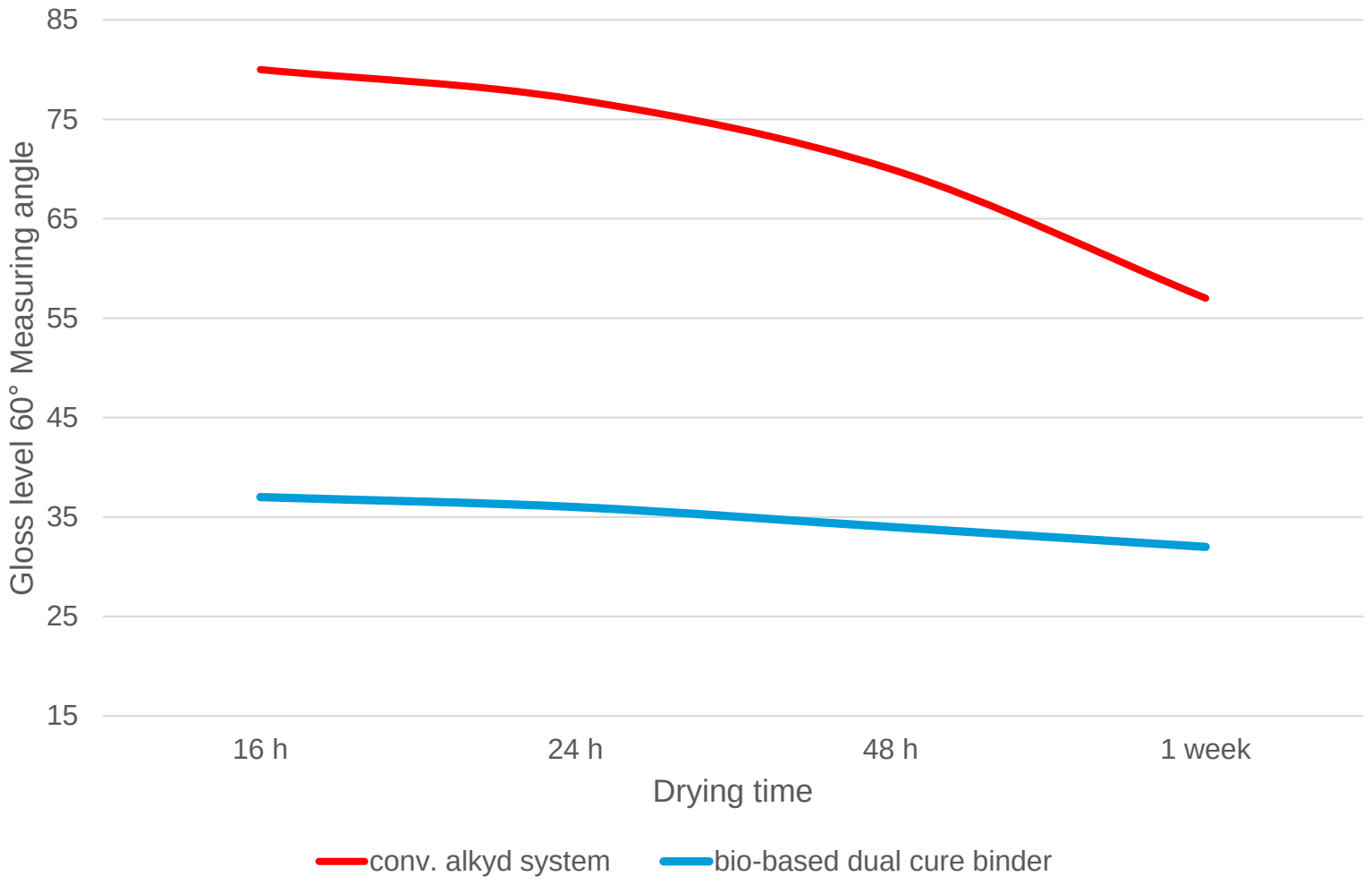
Normal alkyd resins for VOC-compliant coatings usually do not achieve MEK resistance of more than 100 double strokes even after a longer drying time.

Compared to conventional alkyd resins, a significantly higher hardness is observed.



The higher initial and also final hardness is also evident in earlier and more mechanically stressable films.

In silk gloss paints, the desired gloss level is achieved much earlier.



Due to the fast cross-linking, film shrinkage takes place faster than with normal alkyd resins.

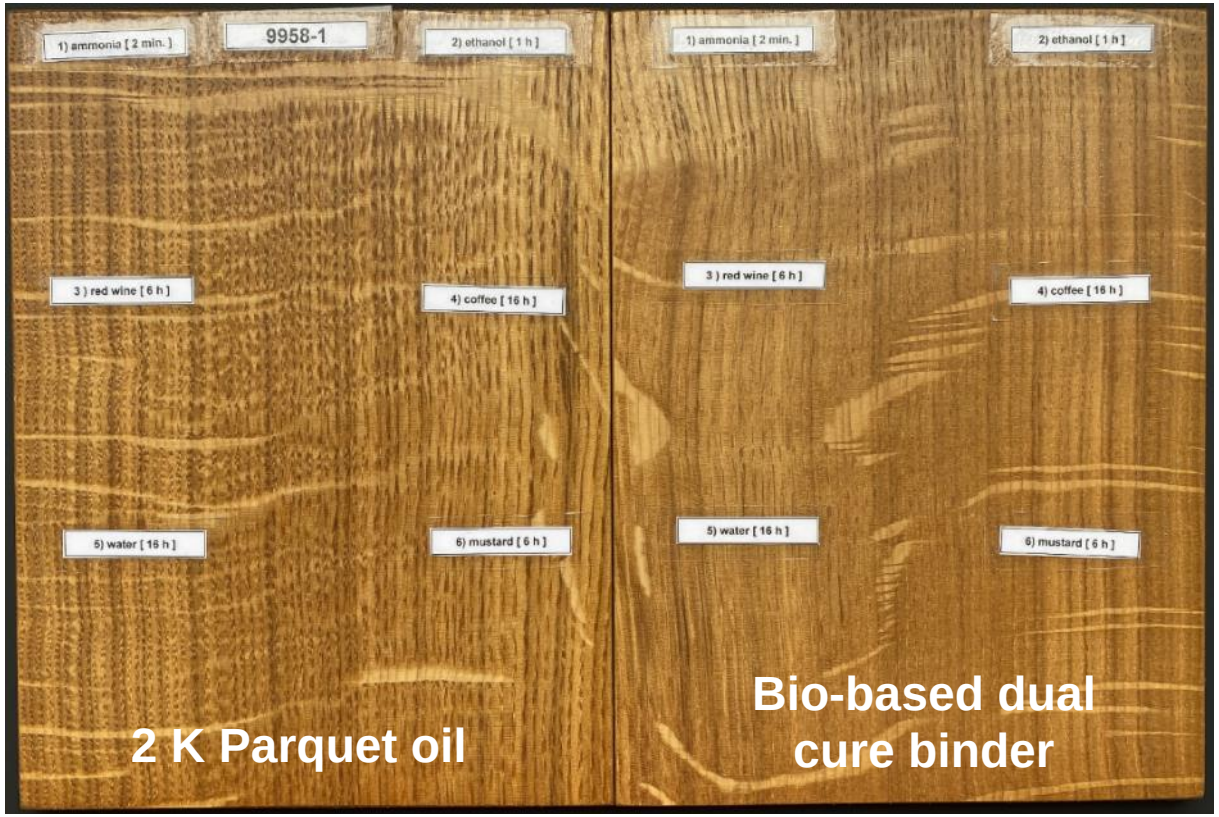
The parquet oil achieves a high solids content, good open time and early resilience.

Guide recipe 1.9978-03

1K UHS Parquet Oil

chemically resistant, oxidative drying, moisture curing

Property	
Non-volatile portion incl. reactive diluent	85,00%
Density, 20° C	0.95 g/cm³
VOC content	< 150 g/l
Drying 50 µm wet film on glass	
Dust dry	1 h
Tack free	6 h
MEK resistance	
after 24 h	50 double strokes
after 1 week	> 200 double strokes



2 * oiled on oak, 1 week drying at r.t.

Good resistance to colouring substances, solvents, cleaning agents and water is achieved. Results are comparable with two component parquet oils.

Summary, opportunities and outlook

Dual cure

Enables significantly improved crosslinking and offers freedom in the formulation of paints and coatings. Resistance properties are on a similar level of two component systems.

Bio-based

Products with a high proportion of bio-based materials can be developed that still meet the highest standards.

Less VOC

The prototype is suitable for formulating VOC-compliant architectural coating systems.
VOC free types are available on request.

Variability

The prototype is suitable for formulating decorative paints, oils and clear coats. **The technology is also suitable for the development of UHS industrial coatings for a wide variety of applications.**

Simplicity

Both the ease of formulation and the ease of application of alkyd resins remain. Almost all known paint raw materials can also be used. It is not necessary to pay attention to special things during production.

Thank you for your attention!

Worlée-Chemie GmbH (Headquarter)

Grusonstraße 26, 22113 Hamburg, Germany

Tel.: +49 40 73333 0
Fax: +49 40 73333 2450

Worlée-Chemie GmbH (Resin factory/Sales)
Worléestraße 1, 21481 Lauenburg, Germany

Tel.: +49 4153 5960
Fax: +49 4153 536 49
Email: service@worlee.de

www.worlee.de