

A scanning electron micrograph (SEM) showing a complex, interconnected network of fibers. The fibers are light-colored against a dark background, forming a dense, porous structure. The fibers vary in thickness and are connected at various points, creating a mesh-like appearance.

Acrodur®:

**An acrylate based
alternative to standard
thermosets ?**

22. Hofer Vliestofftage 2007 / Nov. 7/8

Dr. Michael Kalbe

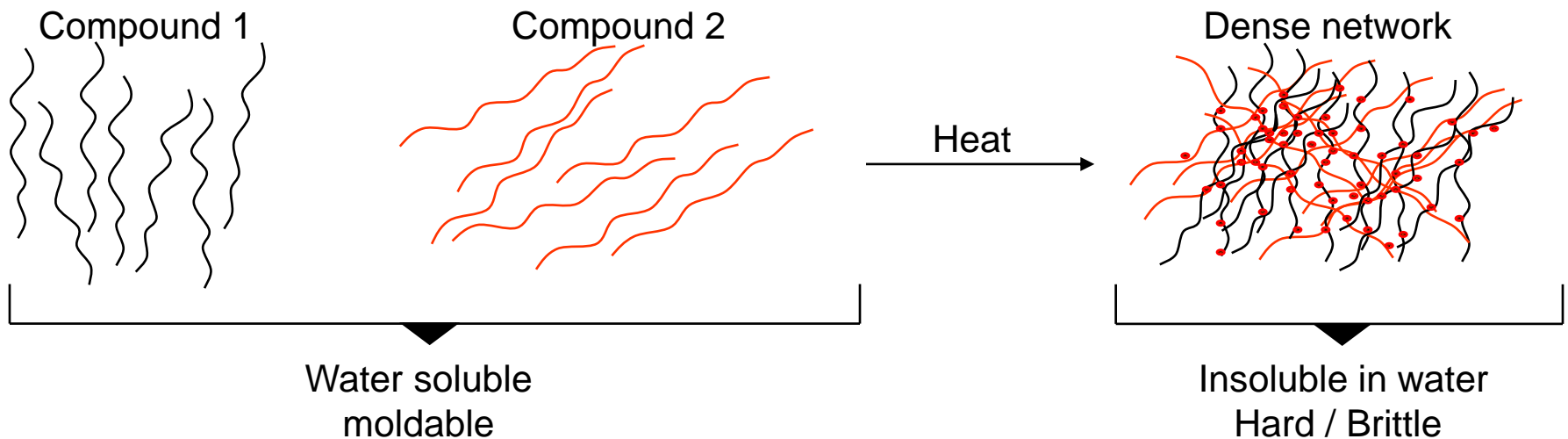
**Polymers for Fiber Bonding:
Expertise you can rely on**

- **Overview on standard thermosets**
- Properties of Acrodur[®]
- Curing behaviour
- Examples for typical Acrodur[®] applications

What are thermosets?

Thermosets consist of a dense network of macromolecules

Standard Thermosets are formed by thermal curing of low-molecular starting material like: **phenol and formaldehyde** or **urea and formaldehyde** or **epoxy resins** ...



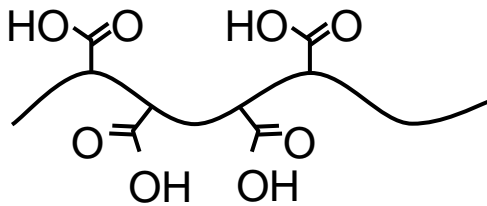
...and **Acrodur®!**

What is Acrodur® ?

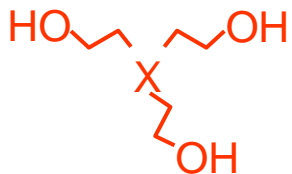
1. Acrodur® solutions

Acrodur® **solutions** consist of two components, dissolved in water

...a **polycarboxylic acid**:

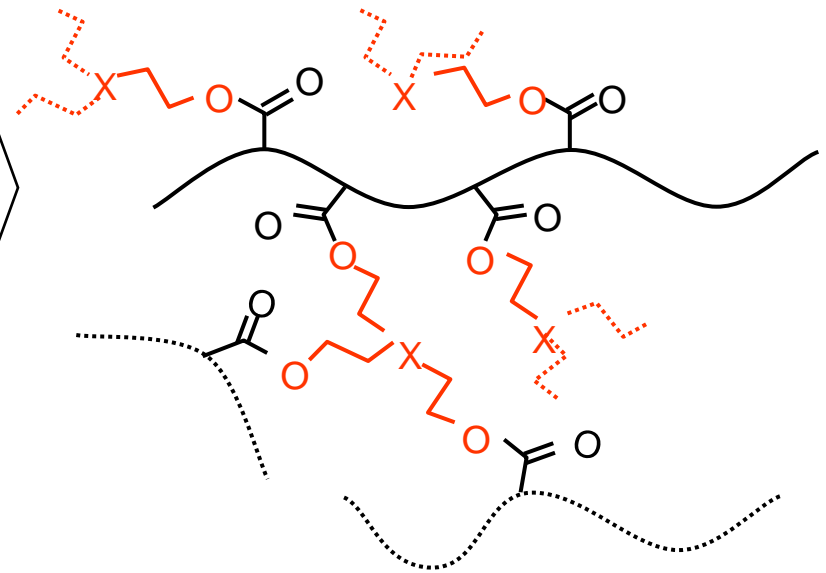


...and a **polyalcohol**:



Both components
react at
temperatures
above > 130 °C

...to form a **polyester**

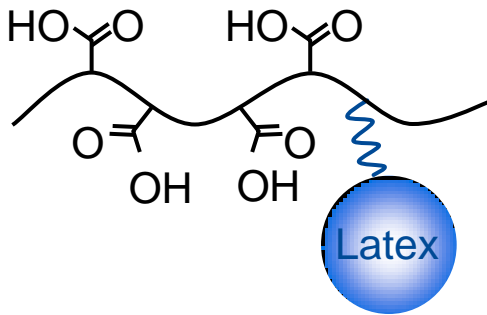


What is Acrodur[®] ?

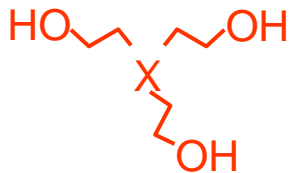
2. Acrodur[®] dispersions

Acrodur[®] **dispersions** consist of two components, dissolved in water

...a **polycarboxylic acid**, modified with a **latex component**:

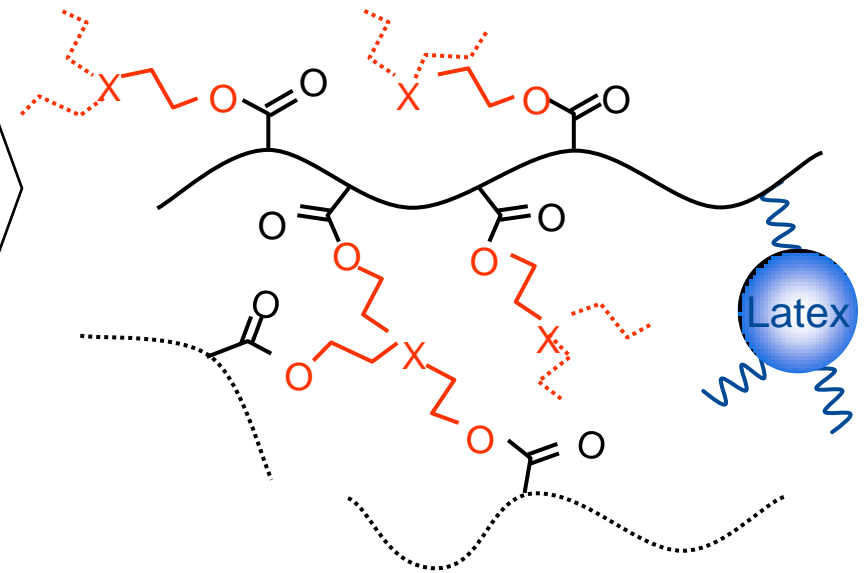


...and a **polyalcohol**:



Both components react at temperatures above $> 130\text{ }^{\circ}\text{C}$

...to form a latexmodified **polyester**



- Overview on standard thermosets
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The Acrodur[®] product portfolio

Product	Characteristics of solution / dispersion			Characteristics of cured polymer	Remarks
	Solid content [%]	pH	Viscosity [mPa · s]		
1st generation Acrodur[®]: Solutions					
Acrodur [®] 950L	50	3-4	900-2500 ($M_w \approx 80 \text{ t g/mol}$)	Stiff-duroplastic High heat resistance	
Acrodur [®] DS 3530	50	2,5-4,5	150-300 ($M_w \approx 12 \text{ t g/mol}$)		
2nd generation Acrodur[®]: Dispersions					
Acrodur [®] DS 3515	50	2,5-4,5	300-1400	<ul style="list-style-type: none"> Hydrophobic Full performance achievable at lower curing temperatures 	Stiff-duroplastic film
Acrodur [®] DS 3558	50	2,5-4,5	300-1400		Flexible duroplastic film

Acrodur® is a class of formaldehyde-free duroplastic acrylic resins and dispersions

Product properties

- 1K-system
- Aqueous solutions or dispersions of modified polyacrylic acid with polyalcohol
- Acidic media, pH = 3,5 ± 1
- Contains no formaldehyde or phenol

Processing properties

- Can be diluted with any amount of water
- Can be used in mixtures with other dispersions
- Can be applied by spraying, rolling or soaking
- Shows good tack
- Forms film at room temperature
- Is thermoplastic before curing
- Can be thermally crosslinked
- Can be cured at temperatures between 130-200 °C

Properties after curing

- Duroplastic
- Water- resistant

Properties of Acrodur[®] solutions

Acrodur[®] 950 L and Acrodur[®] DS 3530

Reactive acrylic resins

Storage stability very good (1-K system)

Miscibility with water unlimited

Solid content [%] 50

pH ca 3,5

Viscosity [mPas]

Acrodur[®] 950 L ca 1.200

Acrodur[®] DS 3530 ca 200

Molecular weight [g/mol]

Acrodur[®] DS 3530 ca 12.000

Acrodur[®] 950 L ca 80.000



Properties of Acrodur[®] dispersions

Acrodur[®] DS 3515 und Acrodur[®] DS 3558

Reactive acrylic dispersions

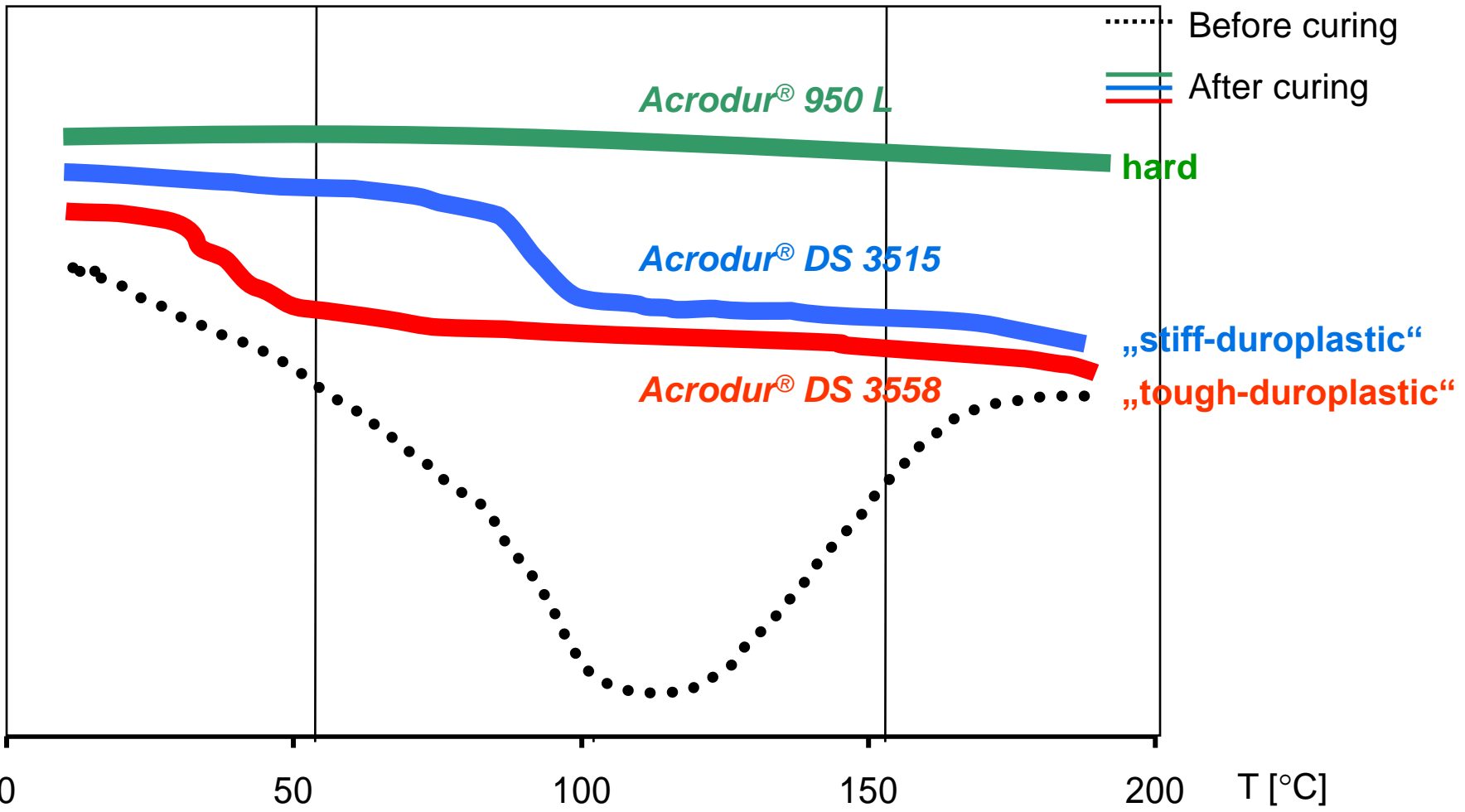
Storage stability	very good (1-K system)
Miscibility with water	unlimited
Solid content [%]	50
pH	ca 3,5
Viscosity [mPas]	ca 700
Molecular weight	high
Latex properties	
Acrodur [®] DS 3558	T _g : 25 °C (flexible duroplastic)
Acrodur [®] DS 3515	T _g : 100 °C (stiff duroplastic)
Particle size Latex	ca 80 nm



- Overview on standard thermosets
- Properties of Acrodur[®]
- **Curing behaviour**
- Examples for typical Acrodur[®] applications

Hard to tough-duroplastic properties can be obtained by using the appropriate Acrodur® binder

E-Modulus [a.u.]

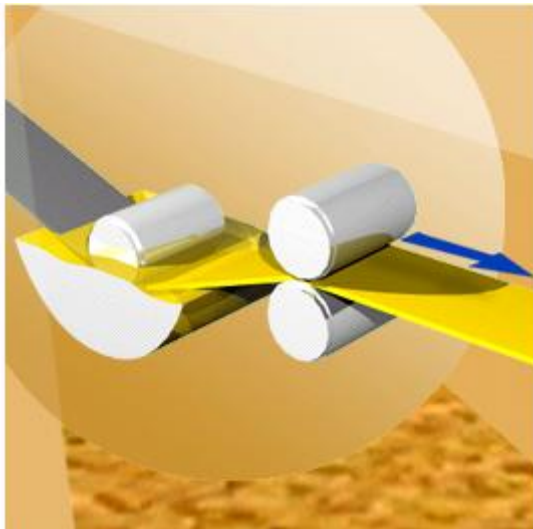


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- **Examples for typical Acrodur[®] applications**

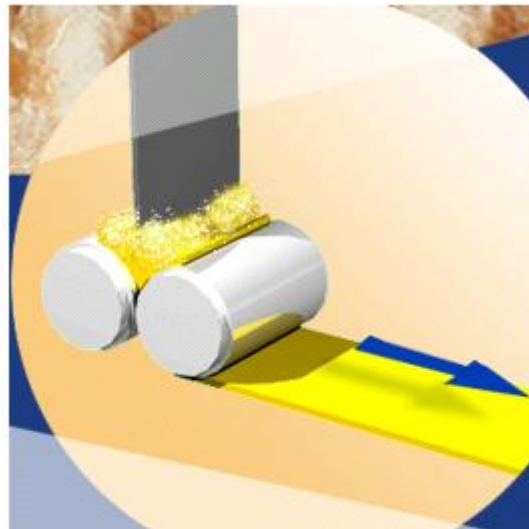
Examples for use of Acrodur®

Application methods

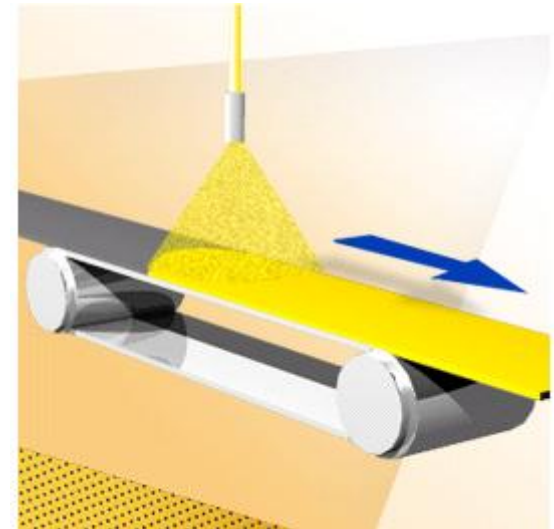
Bath impregnation



Foam impregnation



Spraying



Examples for use of Acrodur®

Binders for wood and natural fibers



Characteristics of natural fiber composites

Substrates

- Wood fibers
- Seed fibers: Cotton
- Bast fibers: jute, hemp, kenaf, flax...

Main application areas

- Automotive (ca 5 – 10 kg natural fibers are used in each car)

Main products

- Door trims
- Rear window shelves
- Sound isolation parts
- Seat shells...





Characteristics of synthetic fiber composites

Substrates

- Synthetic fibres as PA, PES, ...
- Cellulosic fibres
- Glas fibres

Main application areas

- Abrasives
- Flooring
-

Main products

- Abrasive materials
- grits coated PET
-

Acrodur® ...

- Aqueous binder system
 - Does not contain critical components like Phenol or Formaldehyd
 - Becomes duroplastic when thermally cured
-
- Acrylic based binder for
 - Wood and bast fibers
 - Nonwovens from glass, polyester, polyamide
 - ...and a variety of other substrates

... an alternative?

Benefits (versus PF resins)

- Formaldehyde and Phenol free
- No formaldehyde will be generated during curing
- B stageable (thermoplastic intermediates)
- Exhaust fume from curing reaction is water
- High heat resistance
- Excellent storage stability
- Runnability as standard acrylic systems
- Mixible with acrylic dispersions for property adjustment