Neuburg Siliceous Earth –
Sandability and Corrosion Protection
for Water-based Primer-Surfacer for Trains, 2C Epoxy, yellow

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Contents

Status Quo

- The use of water-based formulations is required for environmental reasons and is subject to complex requirements in terms of design, functionality or weathering stability.
- The often applied multi-layer coating structure and the slower drying properties compared to solvent-based systems, however, represent time-consuming and energy-intensive process steps.
- To compensate for this, a more economical, faster to process coating concept would be desirable, in particular early and quick sanding properties.
- Ideally, the contribution to the level of corrosion protection required for the application is retained or even improved.

Objective

Is the well-known positive effect of Neuburg Siliceous Earth on drying behavior and sandabitity exploitable to apply coatings with aqueous paints more efficiently?

Assessment of the performance of

- Barium sulfate ppt
- Talc
- Aktisil AM
- Aktifit AM

Base formulation: Primer-Surfacer for trains, water-based, 2C EP

Major requirements: Sandability and corrosion protection

Base formulation

Component A			parts by weight [pbw]
Pigment paste	Water demineralized		15.1
Pigment paste	Additol VXW 6208	dispersing additive	3.3
Pigment paste	Additol VXW 6393	defoamer	0.1
Pigment paste	Kronos 2190	pigment, white	8.0
Pigment paste	Bayferrox 3920	pigment, yellow	2.5
Pigment paste	Bayferrox 130	pigment, red	0.03
Pigment paste	**Filler**	**varied**	**x**
	Additol VXW 6393	defoamer	0.05
	Texanol	solvent	0.6
	Additol VXW 6388	rheology modifier	0.6
	Methoxypropanol	solvent	1.0
	Beckocure EH 2261w/41WA	aliph. polyamine adduct dispersion, HEW 1100 g/mol	24.2
	TACorr MSW	org. corrosion inhibitor	2.0
	flashpro TAC C4E	flash rust inhibitor	0.4
	Water demineralized		1.4
	Total		**59.3 + x**
Component B			
	Beckopox EP 387w/52WA	solid epoxy resin dispersion, EEW 1000 g/mol	41.3
	Water demineralized		4.6
	Total		**45.9**
Total A + B			**105.2 + x**
	Stoichiometric crosslinking ratio amin/epoxy		**0.53**

Fillers and Combinations

[pbw]	Control with barium sulfate ppt		Replacement of filler			
		Filler Dosage increased	substitution by equal volume			
			+ Talc	NSE* + Talc		NSE pure
Barium sulfate ppt	45	75	50			
Talc			15	15	15	
Aktisil AM				30		44
Aktifit AM					30	
PVC [%]	32	42	constant			

i Filler characteristics

i Structure of NSE* = Neuburg Siliceous Earth

Final Formulations

Component A [pbw]		PVC 32 %	PVC 42 %				
		Control Barium sulfate ppt		+ Talc	Aktisil AM + Talc	Aktifit AM + Talc	Aktisil AM
Water demineralized		15.1	17.5	19.1	30.5	30.5	32.0
Additives / Pigments		13.93	13.93	13.93	13.93	13.93	13.93
Barium sulfate ppt		45	75	50			
Talc				15	15	15	
Aktisil AM					30		44
Aktifit AM						30	
Additol VXW 6393		0.05	0.05	0.05	0.05	0.05	0.05
Texanol		0.6	0.6	0.6	0.6	0.6	0.6
Additives / Hardener		28.2	28.2	28.2	28.2	28.2	28.2
Water demineralized		1.4	---	---	---	---	---
		104.3	135.3	126.9	118.3	118.3	118.8
Component B		45.9					
Total A + B		150.2	181.2	172.8	164.2	164.2	164.7
Solids content [%]	w/w	59.9	66.4	63.7	54.8	54.8	54.3
	v/v	41.4	44.7	43.9	39.8	39.8	39.5

Pigment paste

Pigment paste

Preparative Methods

Processing and Mechanical Properties

	Barium sulfate ppt	Barium sulfate ppt	Barium sulfate ppt + Talc	Aktisil AM + Talc	Aktifit AM + Talc	Aktisil AM
Viscosity Component A	stable	changing	changing	stable	stable	stable
Storage stability	moderate	poor	poor	good	moderate	very good ✓
Viscosity Component A + B	low	very high	very high	moderate	low	high
Pendulum hardness	comparable			higher		
Adhesion	very good			very good		
	PVC 32 %			PVC 42 %		

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Sandability by Machine – Rotation / fast

at 500 revolutions min^{-1}						
Pre-drying 16 h 23 °C	0	1	1	2 - 3	3 - 4	2
+ 2 h 60 °C Convection drier	1	2	3 - 4	3 - 4	4 - 5	2
at 2000 revolutions min^{-1} more critical: stronger adhesion of grinding dust						
Pre-drying 16 h 23 °C	0	0	1	2 - 3	3 - 4	2
+ 2 h 60 °C Convection drier	1	2 - 3	4	4 - 5	5 ✓	3
	Barium sulfate ppt	Barium sulfate ppt	Barium sulfate ppt + Talc	Aktisil AM + Talc	Aktifit AM + Talc	Aktisil AM

Filler synergy

Optimum

PVC 32 % ——— PVC 42 % ———

Assessment of amount of removable fine dust:
0 = not sandable, 5 = ideal sandable

i Procedure and detailed results

Sandability manually – Lateral Strokes / slow

at 50 double strokes 1 double hub s^{-1}						
Pre-drying 2 h 40 °C Convection drier	0	1	0 - 1	1	2	3
16 h 23 °C	0	2	1 - 2	2 - 3	3	4 Optimum
+ 2 h 60 °C Concection drier	3	3 - 4	3	4	4 - 5	5
	Barium sulfate ppt	Barium sulfate ppt	Barium sulfate ppt + Talc	Aktisil AM + Talc	Aktifit AM + Talc	✓ Aktisil AM

PVC 32 % PVC 42 %

Assessment of amount of removable fine dust:
0 = not sandable, 5 = ideal sandable

i Procedure and detailed results

Sandability by Machine / manually – Overal Rating

Barium sulfate ppt → unsatisfactory

- higher rotational speed / additional convective drying phase practically ineffective
- acceptable results require manual sanding at higher load weight and additional higher drying temperatures

Combination with Talc → only useful with restrictions

- in machinery grinding test: additional drying time at 60°C convection needed to improve poor sandability and to reduce dust sticking
- in manual grinding: stronger lubricating effect and worser result than with pure barium sulfate, even after additional short forced drying

Neuburg Siliceous Earth → for best results

- better sanding at early stage of drying
- for machine grinding with maximum effect: Talc + Aktifit AM
- for manual sanding at higher weight load: Aktisil AM pure

Corrosion Test – Assessment after 300 h Salt Spray Test

Barrier protection non-scribed area						
Adhesion 24 h	very poor	poor	good - very good	very good	good – very good	good
0 h = Wet adhesion	very poor	very poor	good	✓ very good	moderate	good - moderate
Blistering resistance	< 72 h	< 72 h	< 72 h	> 300 h	> 300 h	> 300 h
Corrosion resistance	very low	very low	low	✓ very high = Optimum		
Protection at scribe Sikkens						
Delamination	> 40 mm	10 mm	6 mm	< 2 mm	< 2 mm	< 2 mm
Blistering- / Corrosion resistance	moderate	very low	low	high	high	high
	Barium sulfate ppt	Barium sulfate ppt	Barium sulfate ppt + Talc	Aktisil AM + Talc	Aktifit AM + Talc	Aktisil AM
	PVC 32 %			PVC 42 %		

Q-Panel R 48, DFT 80 µm

i Procedure and detailed results

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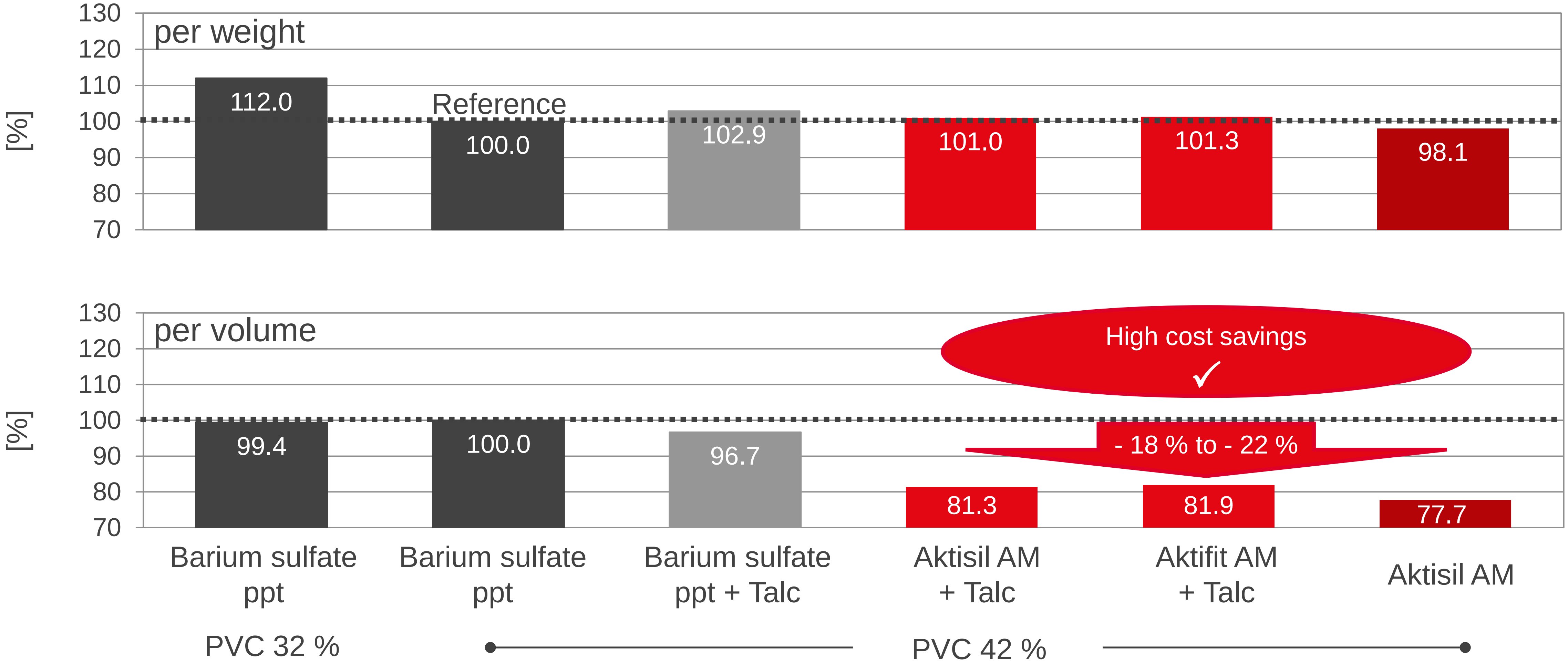
Cost Index

Reference wet paint = 100 % (Germany 2021)



Results (1)

Barium sulfate ppt

- easy processability but causes lack of viscosity stability and sedimentation stability during storage
- Sandability and corrosion protection proves insufficient

Combination with Talc

- speeds up sedimentation tendency and hard sediment formation
- acceptable sandability requires fast grinding speed under low weight load and extended drying time
- Improvement in poor anti-corrosion performance limited to better adhesion and lower delamination at scribe. Strong blistering tendency remains and leads to metal corrosion.

Results (2)

Neuburg Siliceous Earth grades boost performance level

- very good storage stability when using Aktisil AM
- faster hardness build-up after paint application
- improved sandability with Aktisil AM and Aktifit AM despite higher water content of formulation
- excellent, easier and earlier sandability whether for machine grinding (Talc + Aktifit AM) or for manual sanding (Aktisil AM used alone)
- short forced drying further improves non-stick behavior to sandpaper.
- much better corrosion resistance and thus significantly longer protection period in non-scribed area (no blistering or metall corrosion)
- Lowest delamination at scribe
- Outstanding paint adhesion even under corrosive conditions (Talc + Aktisil AM)

Customer Benefits

Aktisil AM and **Aktifit AM** overcome existing drawbacks of typically used fillers in water-based primer-surfacer coatings:

- Enhanced sandability
  - ✓ More efficient, earlier or at lower drying temperature
  - ✓ More productive faster coating process
- Reduced sticking to sandpaper
  - ✓ Longer lasting grinding performance and service life of paper
  - ✓ Saving of maintenance work, waste as well as material cost

- Improved corrosion protection
  - ✓ Higher performance and durability of the coating
  - ✓ No aktive anti-corrosive pigment needed

- Further savings
  - ✓ Resources (lower raw material dosage)
  - ✓ Formulation costs

Starting Formulations – Parts by Weight

Component A		[1]	[2]	[3]
Pigment paste	Water demineralized	29.1	29.1	29.1
	Additol VXW 6208	3.3	3.3	3.3
	Additol VXW 6393	0.1	0.1	0.1
	Kronos 2190	8.0	8.0	8.0
	Bayferrox 3920	2.5	2.5	2.5
	Bayferrox 130	0.03	0.03	0.03
	Talc	15	15	
	Aktisil AM	30		44
	Aktifit AM		30	
	Additol VXW 6393	0.05	0.05	0.05
	Texanol	0.6	0.6	0.6
	Additol VXW 6388	0.6	0.6	0.6
	Methoxypropanol	1.0	1.0	1.0
	Beckocure EH 2261w/41WA	24.2	24.2	24.2
	TACorr MSW	2.0	2.0	2.0
	flashpro TAC C4E	0.4	0.4	0.4
	Total	**118.3**	**118.3**	**118.8**
Component B				
	Beckopox EP 387w/52WA	41.3	41.3	41.3
	Water demineralized	4.6	4.6	4.6
	Total	**45.9**	**45.9**	**45.9**
Total A + B		**164.2**	**164.2**	**164.7**

Stoichiometric crosslinking ratio amin/epoxy 0.53 / Solids content w/w 55 % / PVC 42 %

[1] good sandability, markedly prolonged corrosion protection with outstanding surface adhesion

[2] effective sandability for machine grinding at high rotation speed, good corrosion protection

[3] Best rheological and sedimentation stability during storage, sandability at early stage, predominantly for manual sanding process, good corrosion protection

If corrosion protection is of less importance, good sandability results are also available with NSE grade Sillitin Z 86.

We supply materials for good ideas!

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Further Information

- Details of test methods and results with pictures
    - Preparative Methods
    - Processing and mechanical properties
    - Sandability by machine / manually
    - Corrosion test
- Structure of Neuburg Siliceous Earth
- Filler Characteristics

Preparative Methods

Mixing


Source: VMA Getzmann

Component A

- Pigment paste: Dissolver with toothed disc (Cowles Blade) 30 min at 8.0 m/s, ice water cooling
- Addition of remaining ingredients at 4.0 m/s (Additol VXW 6388 and methoxypropanol premixed)

Component B

- Mixing of blend of epoxy binder and water with component A for 2 min at paddle mixer

Application

Substrate: cold rolled steel Q-Panel Type R 48

Single-Layer: undiluted with doctor blade 12 mm/s on automated film applicator
dry film thickness ~ 80 µm

Conditioning

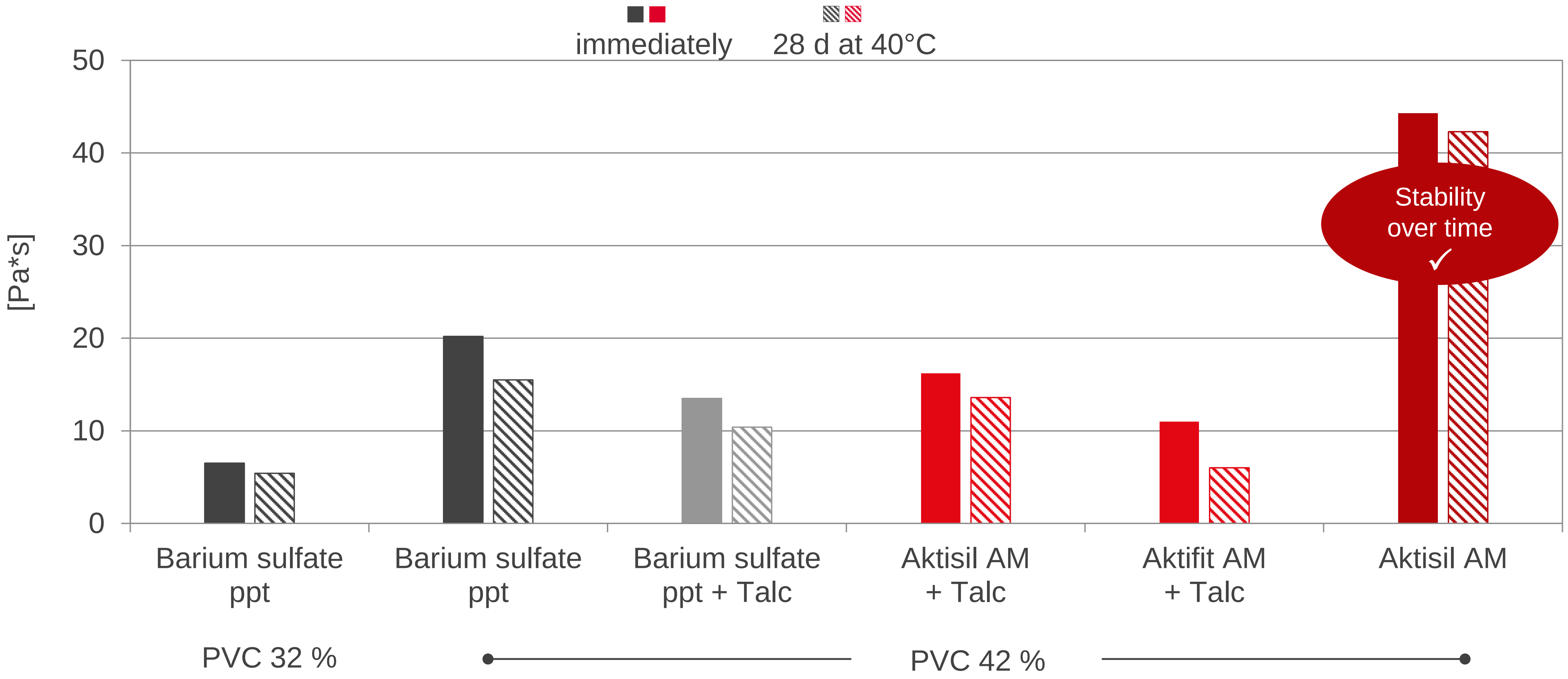
Drying at 23°C / 50 % relative humidity

- Pendulum hardness, sandability: varied times
- Adhesion, corrosion test: 7 days

Viscosity A-Component and „Rheological Stability over time“

at low shear rate 0.01 s^{-1}

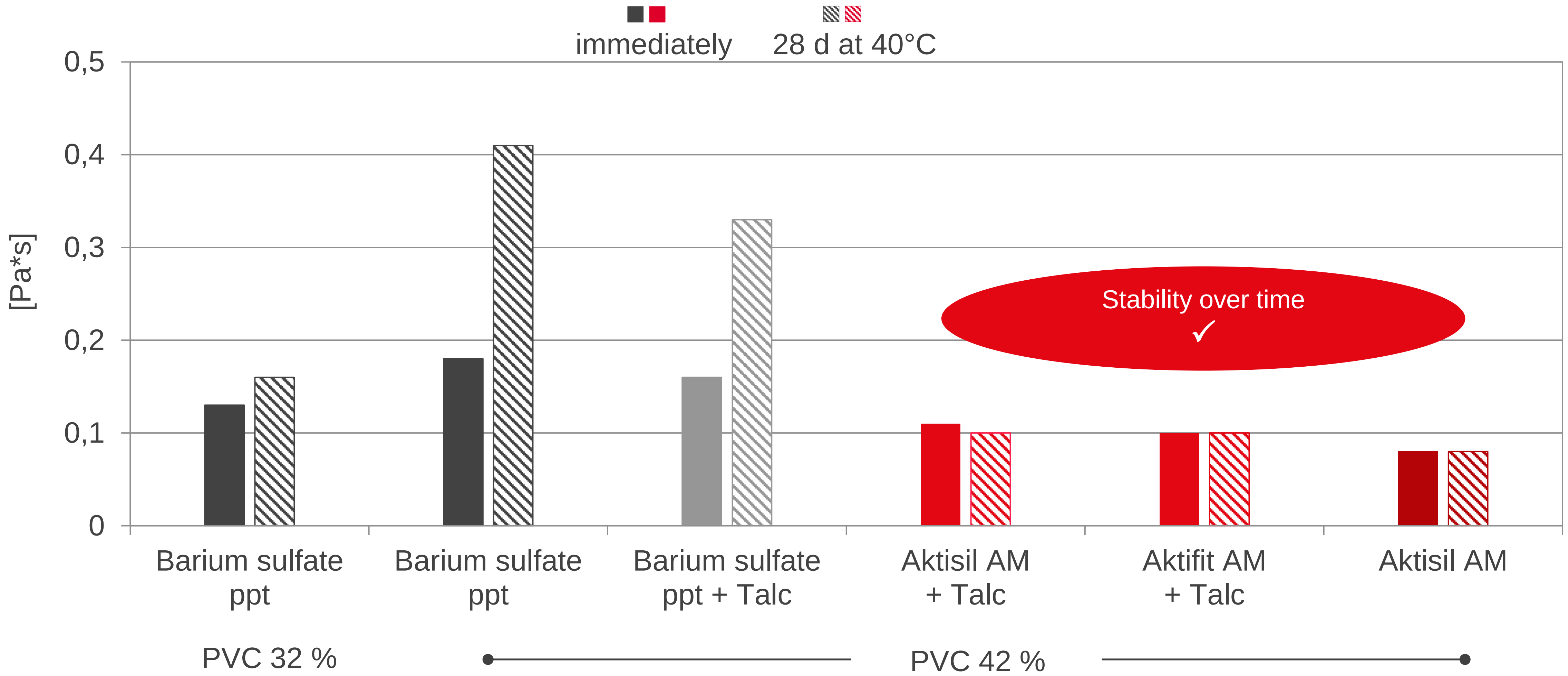
MCR 300 / CC17 / 23°C



Viscosity A-Component and „Rheological Stability over time“

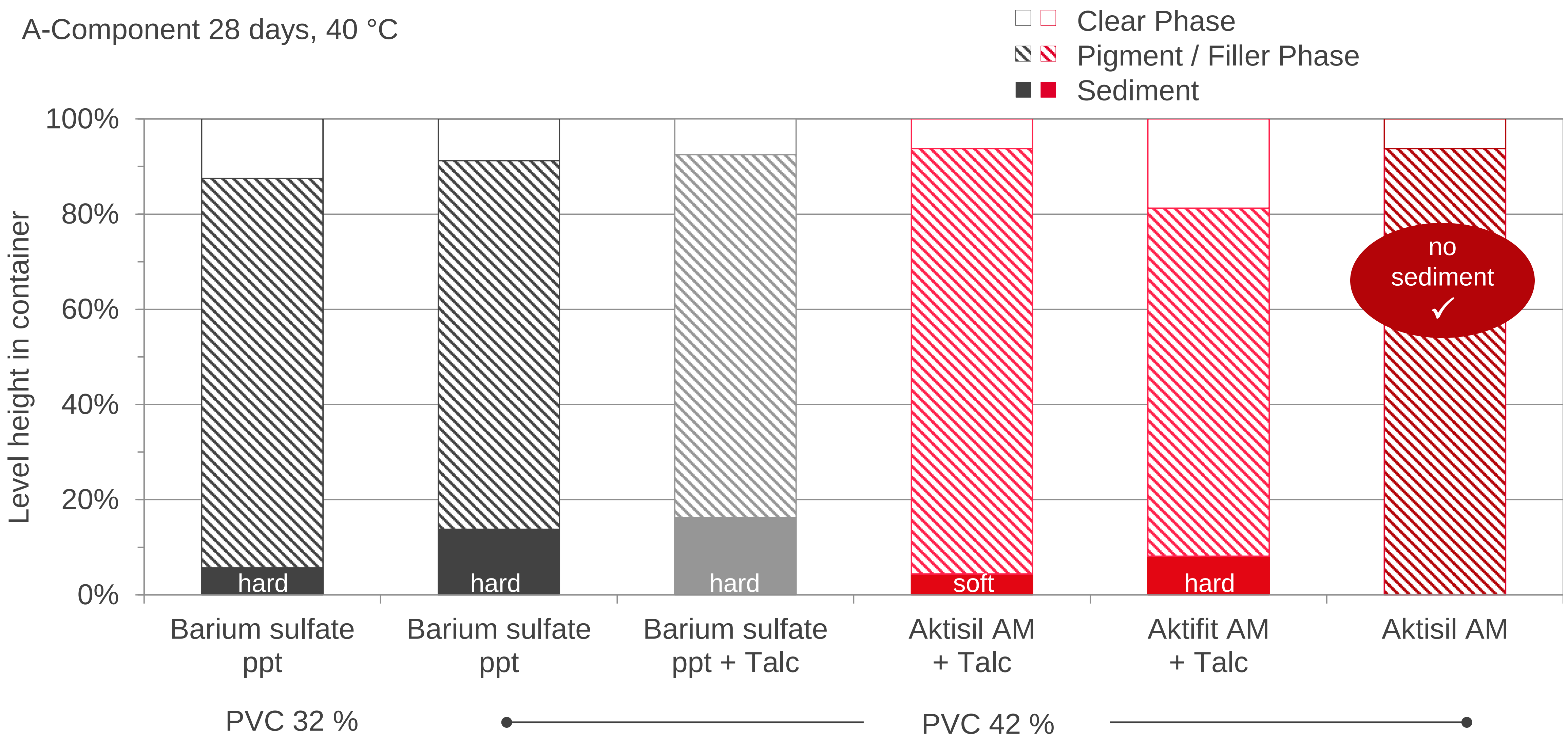
at high shear rate 1000 s^{-1}

MCR 300 / CC17 / 23°C



Storage Stability

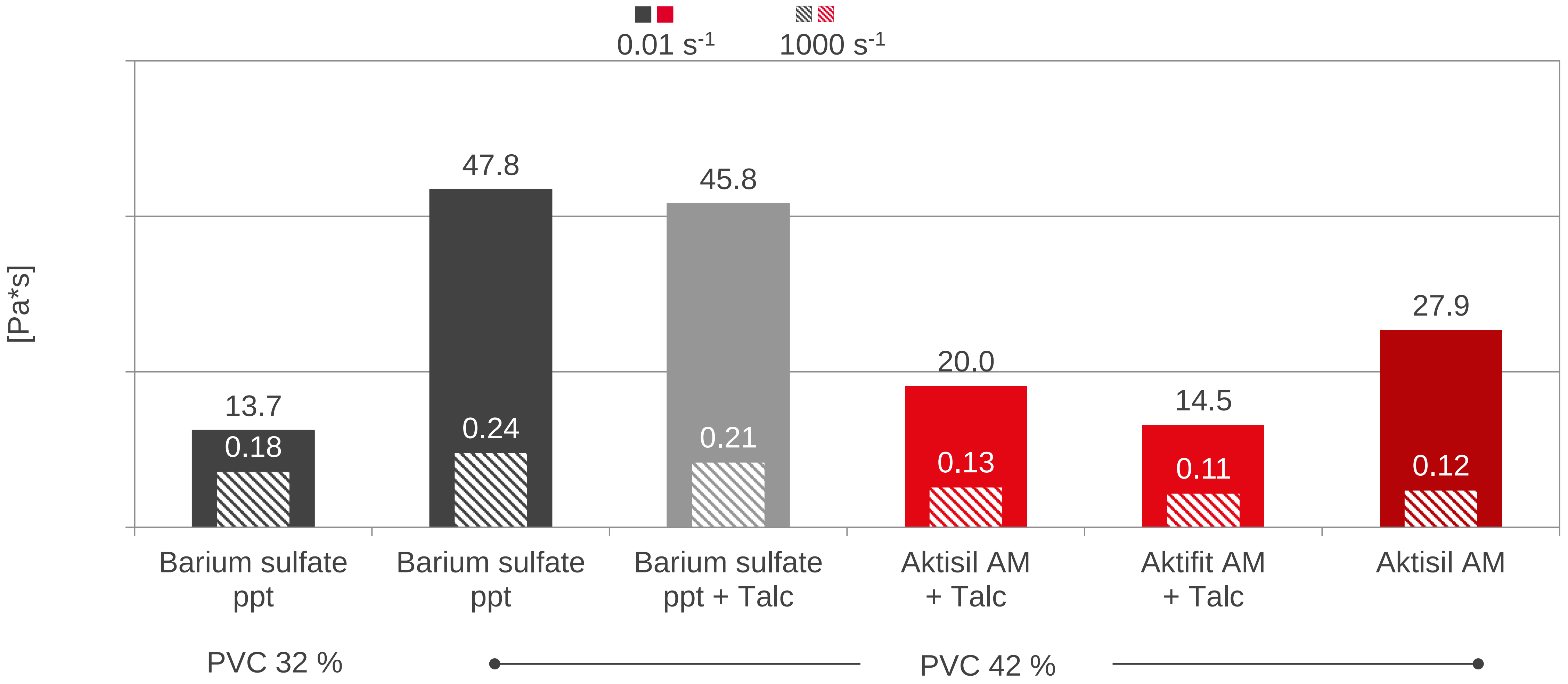
A-Component 28 days, 40 °C



Viscosity Component A+B

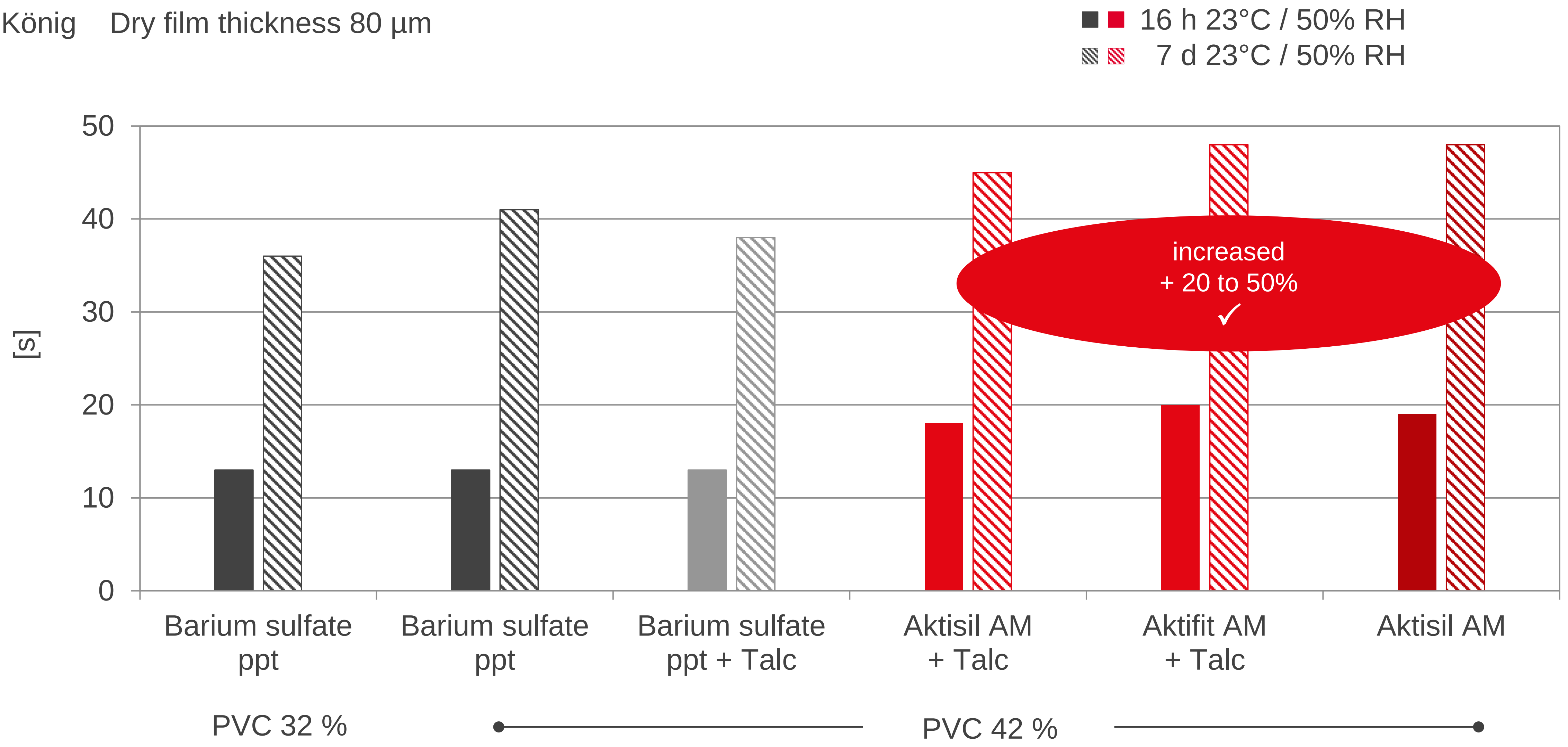
At low and high shear rate

MCR 300 / CC17 / 23 °C



Pendulum Hardness

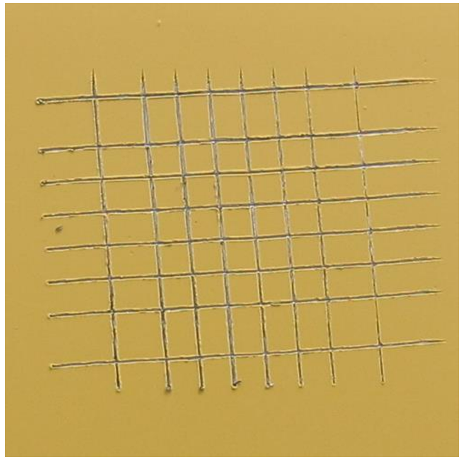
König Dry film thickness 80 µm

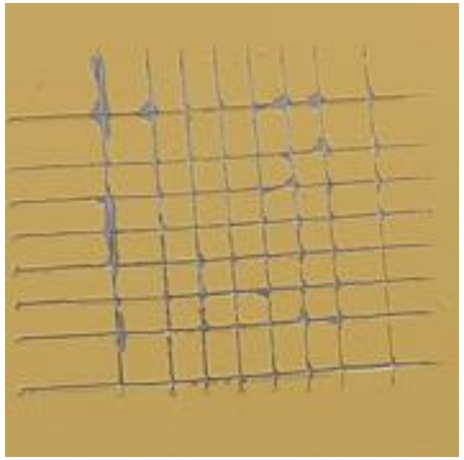


Adhesion

Cross-cut test 2 mm, tape tear-off - Dry film thickness 80 µm

Excellent rating range: all Variants GT ≤ 1





Sandability by Machine – Polish Test Bench

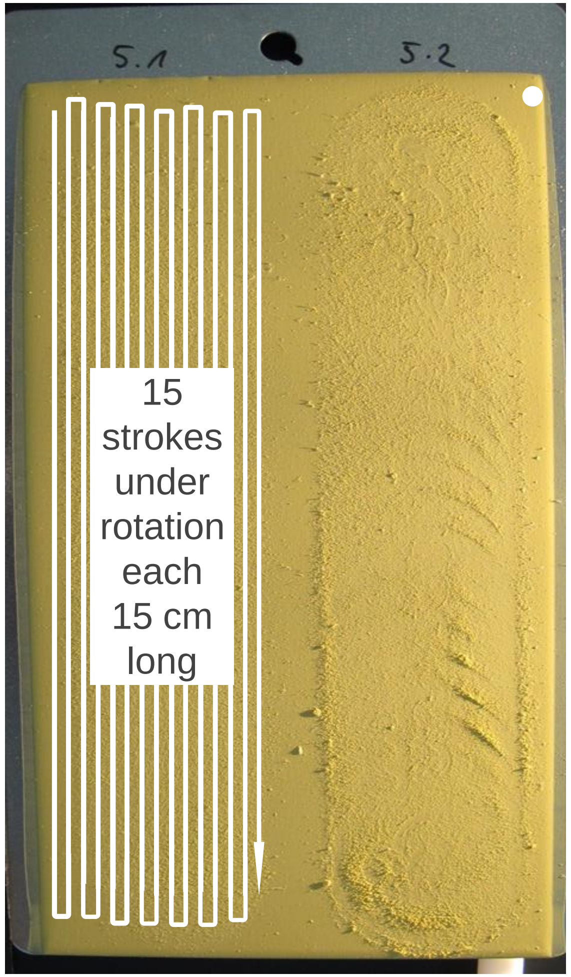
- ✓ Close to industrial procedure
- ✓ Qualitative + Quantitative

Testing conditions:

- ➢ Dry grinding without dust suction
- ➢ Sandpaper grit P240
- ➢ High speed rotation
  500 or 2000 revolutions / min
  + lateral strokes 3.5 cm / s
- ➢ Weight load 100 g = 14 g / cm²

Sandability by Machine – Polish Test Bench

Test Procedure



Coating:

- Dry film thickness 80 µm

Drying: varied

- 16 h 23°C 50% RH
- 16 h 23°C 50% RH
  + 2 h 60°C convection drier

Evaluation: abrasive material loss

- Quality
- Quantity gravimetrically
  non-sticking / sticking

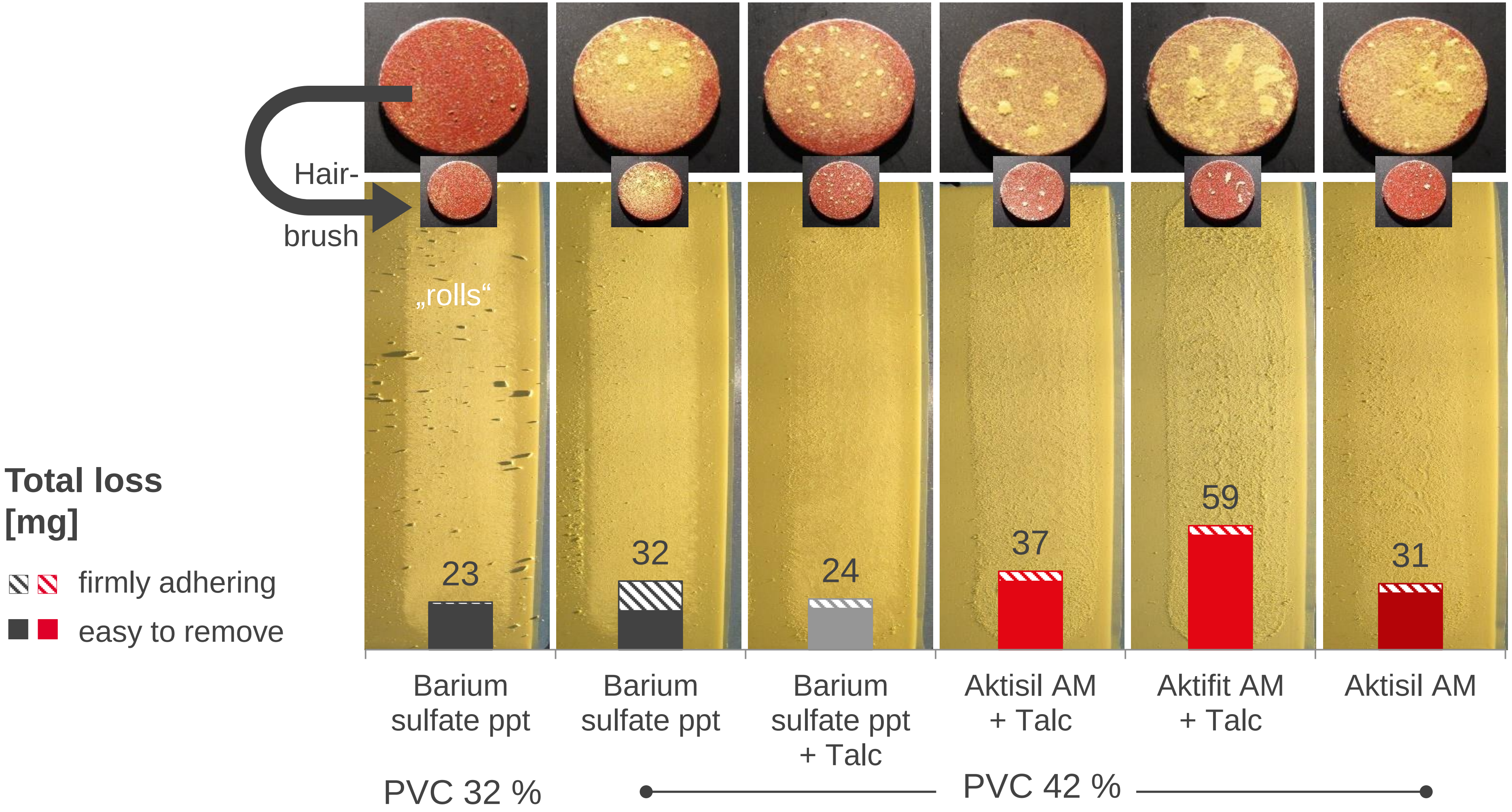
Hair brush →

Problem:

Adhering dust islands reduce grinding power !

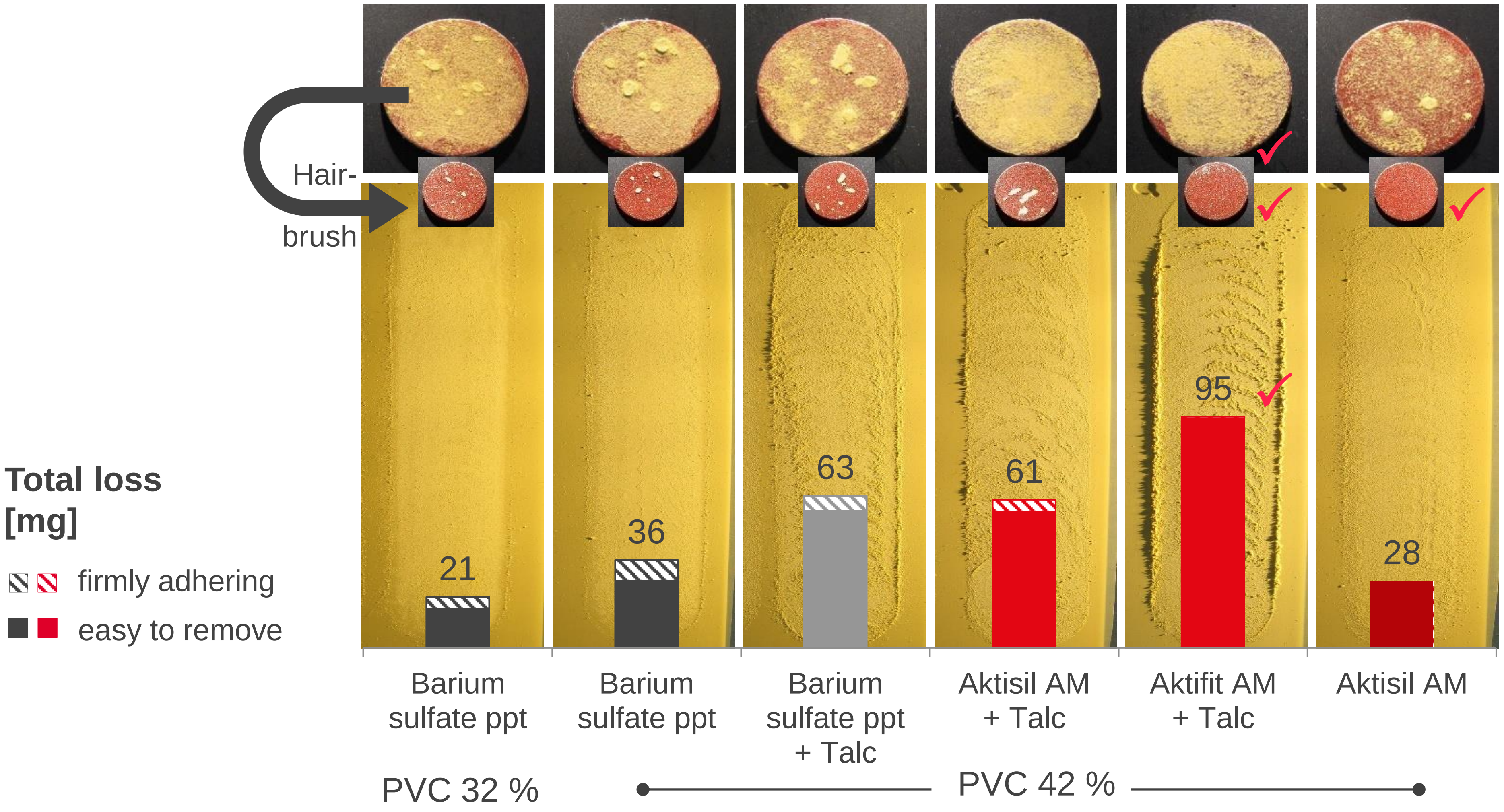
Sandability by Machine, 500 rev. min^{-1}

Drying 16 h 23°C



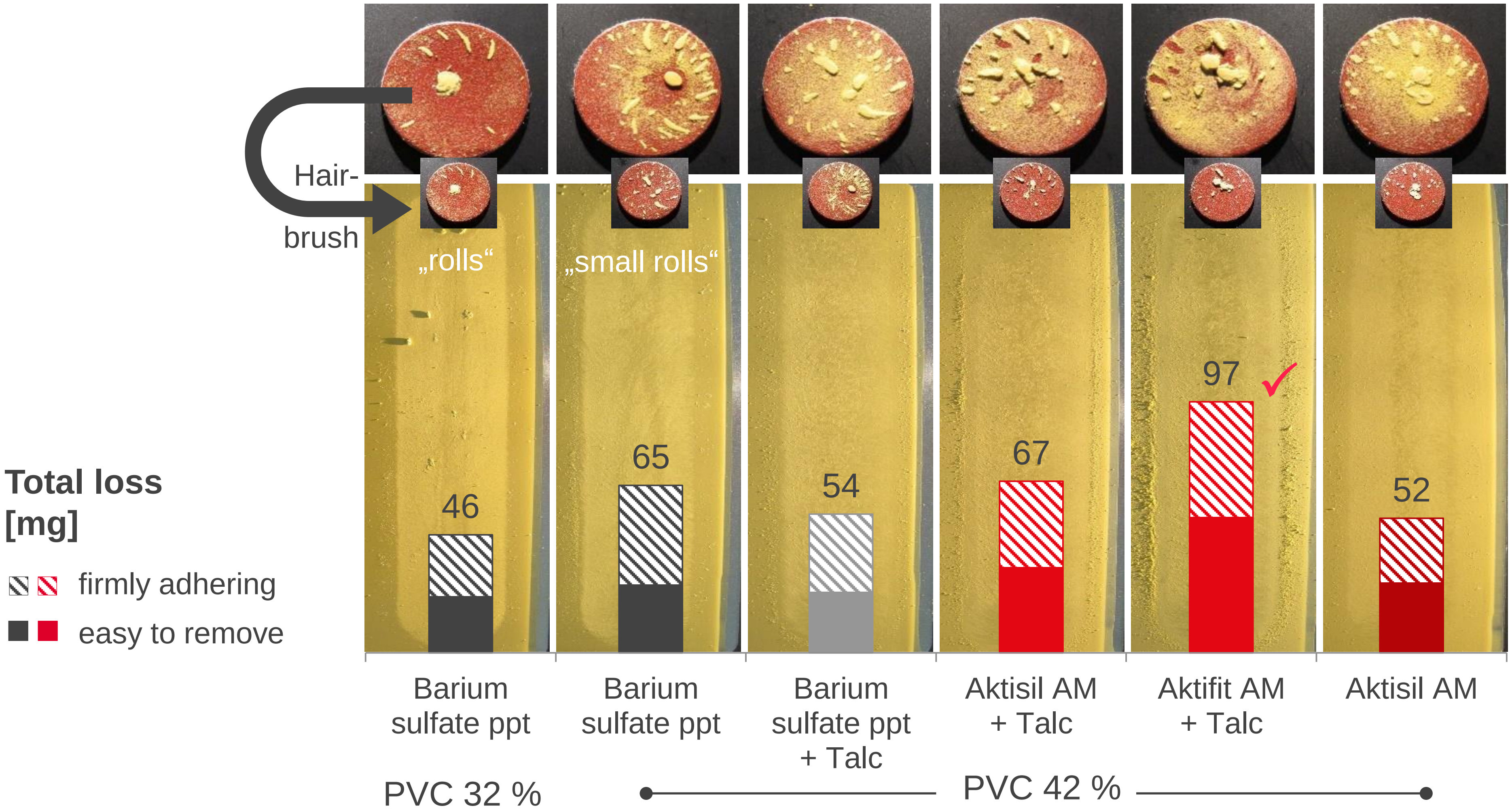
Sandability by Machine, 500 rev. min^{-1}

Drying 16 h 23°C + 2 h 60°C convection drier



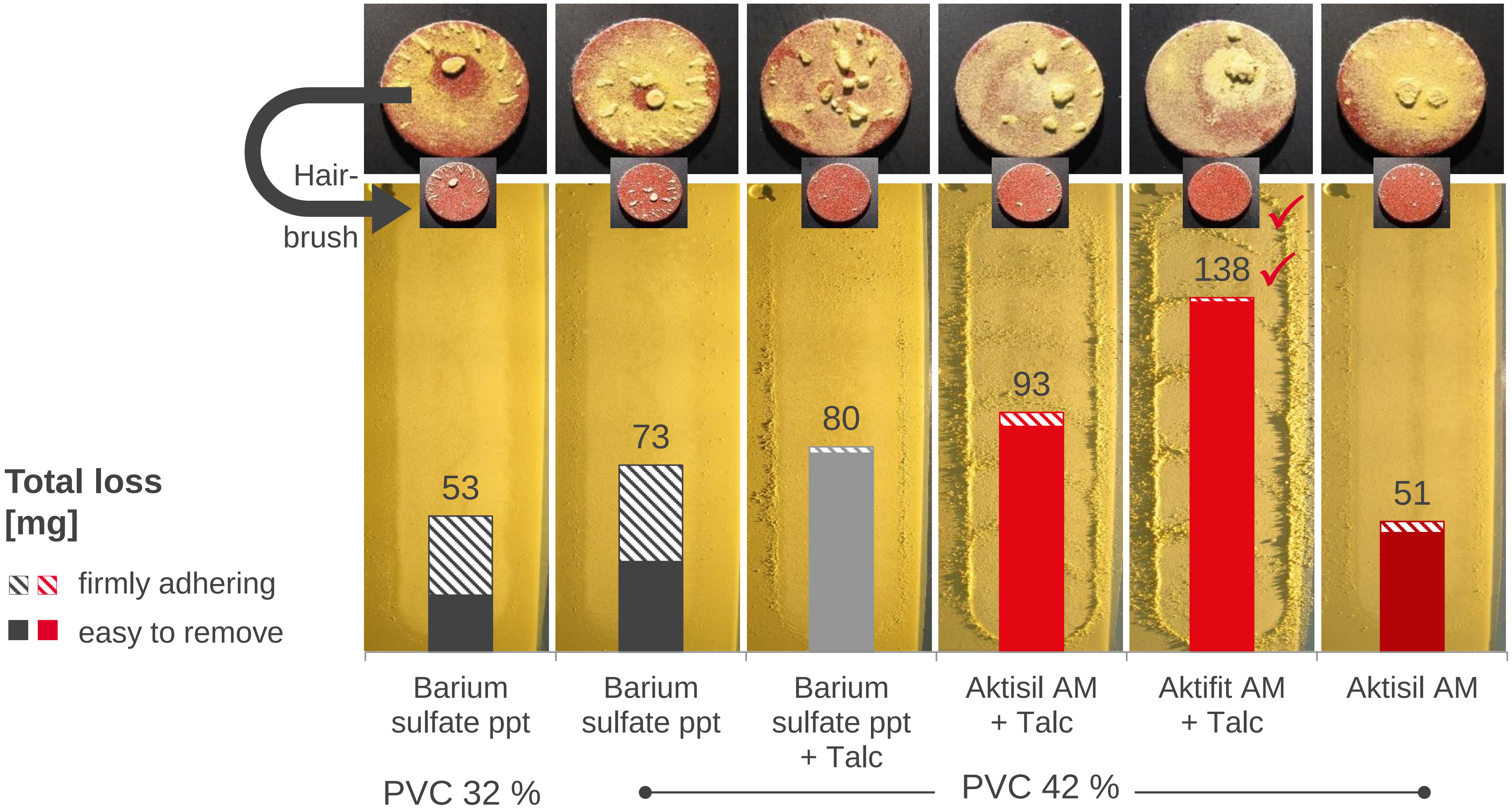
Sandability by Machine, 2000 rev. min^{-1}

Drying 16 h 23°C



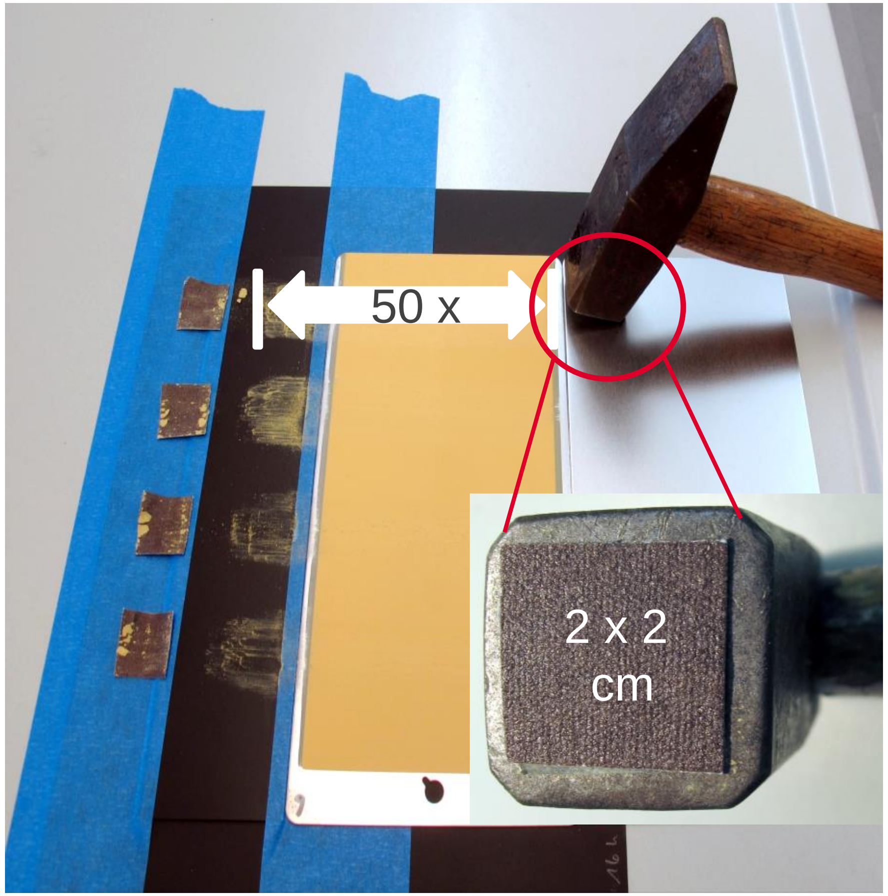
Sandability by Machine, 2000 rev. min^{-1}

Drying 16 h 23°C + 2 h 60°C convection drier



Sandability manually – Hammerhead at higher Load

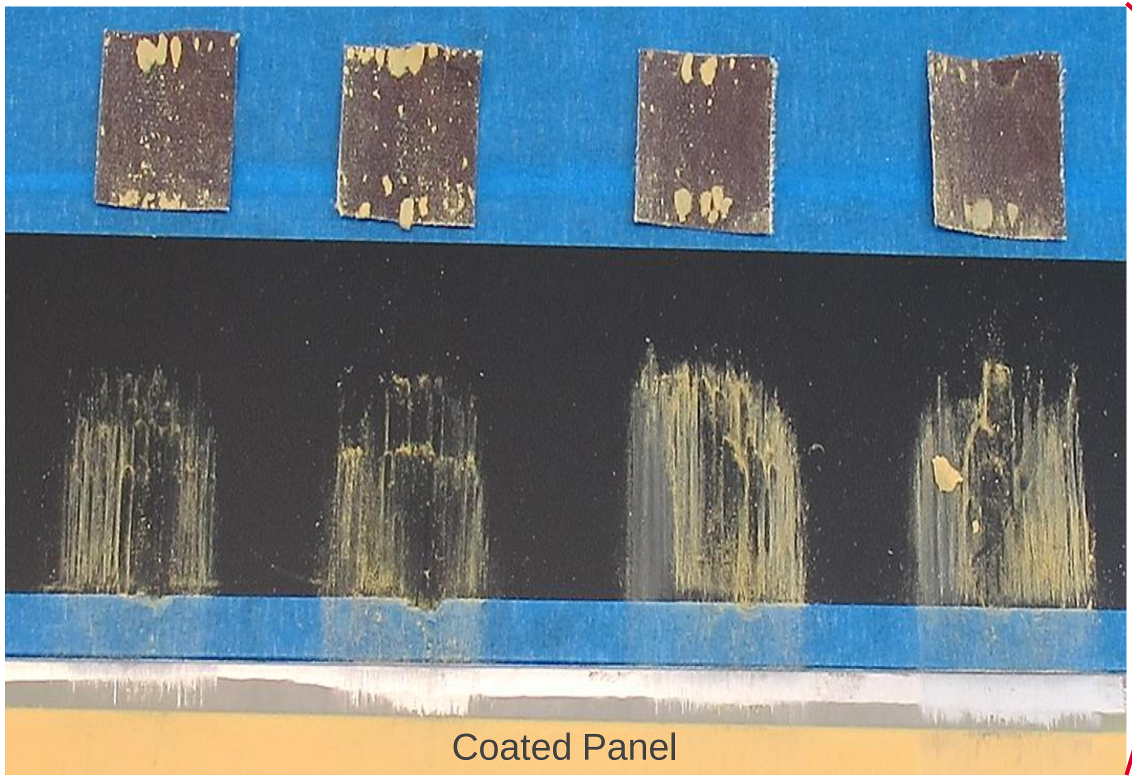
✓ Laboratory test for quick results

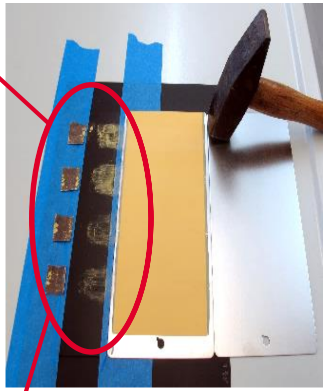


Testing conditions:

- Dry grinding without dust suction
- Sandpaper grit P240
- Low speed 50 double strokes
  1 double hub / s
- Weight load 500 g = 125 g / cm²

Sandability manually – Hammerhead at higher Load





Coating:

- Dry film thickness 80 µm

Drying: varied

- 2 h 40°C convection drier
- 16 h 23°C 50% RH
- 16 h 23°C 50% RH + 2 h 60°C convection drier

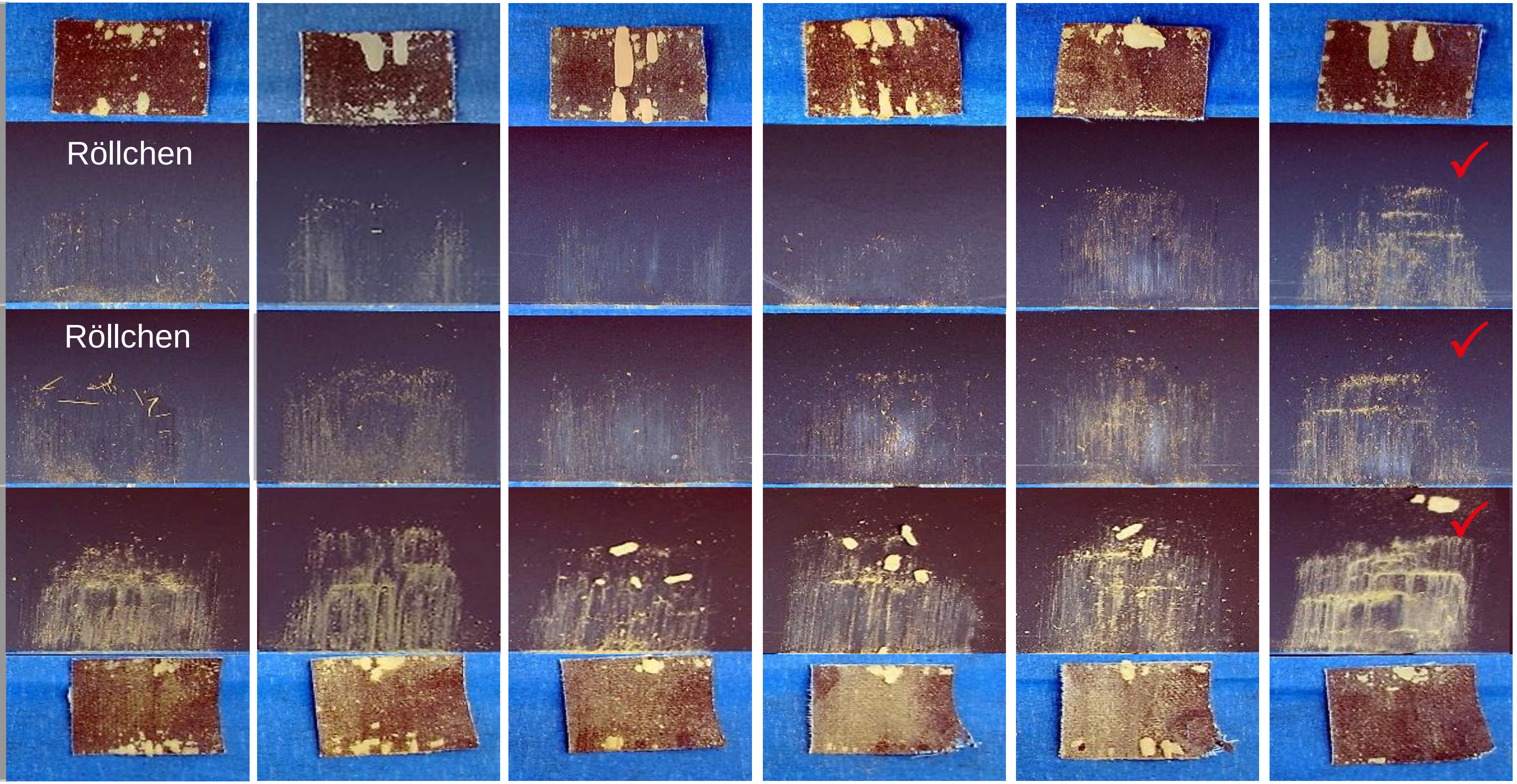
Evaluation:

Abrasive material loss

- Quality
- Quantity, non-sticking

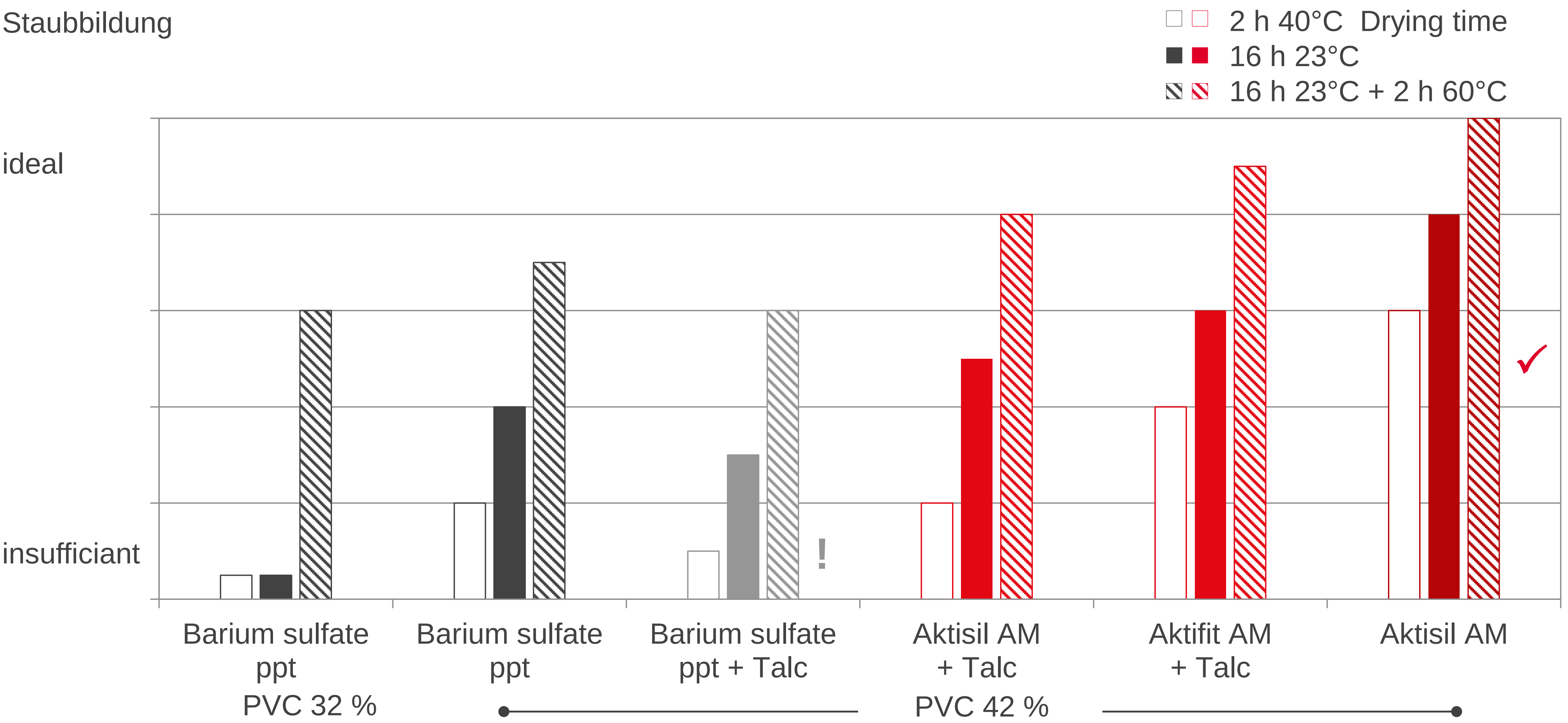
Sandability manually – Visual Performance

Drying	
2 h 40 °C Convection drier	
16 h 23 °C	
16 h 23°C + 2 h 60 °C Convection drier	



Barium sulfate ppt	Barium sulfate ppt	Barium sulfate ppt + Talc	Aktisil AM + Talc	Aktifit AM +Talc	Aktisil AM
PVC 32 %		PVC 42 %			

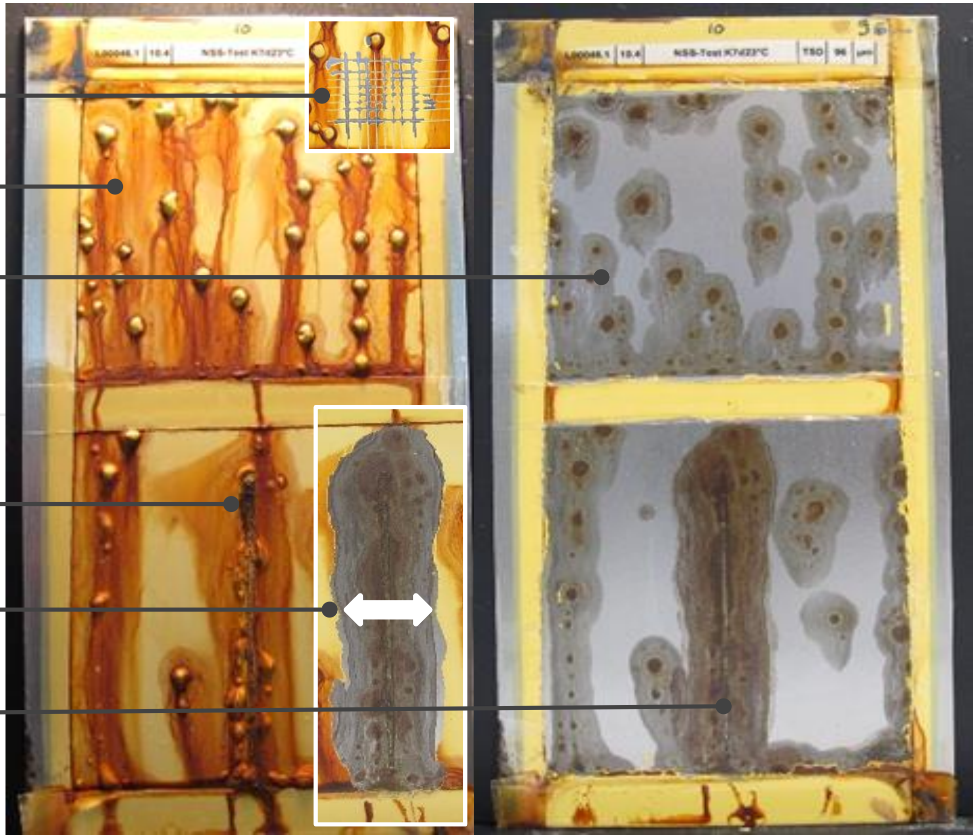
Sandability manually – Relative Performance



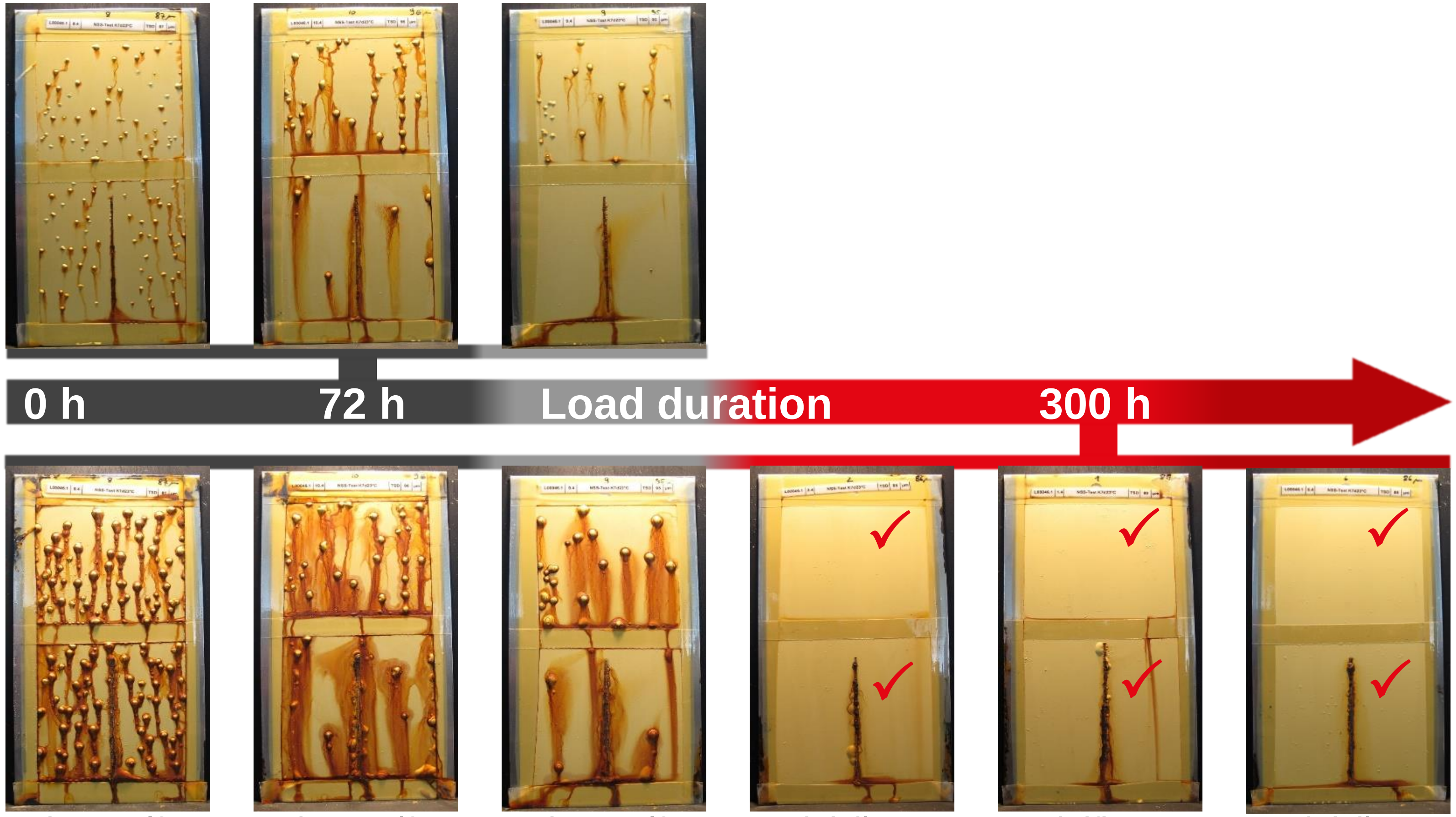
Corrosion Test

Evaluation criteria

Salt Spray Test	DIN EN ISO 9227 NSS
Non-scribed area	• Adhesion • Blistering • Corrosion stripped
Scribed area Sikkens 1 mm width 7 cm long	• Blistering • Delamination • Corrosion stripped



Salt Spray Test – Appearance

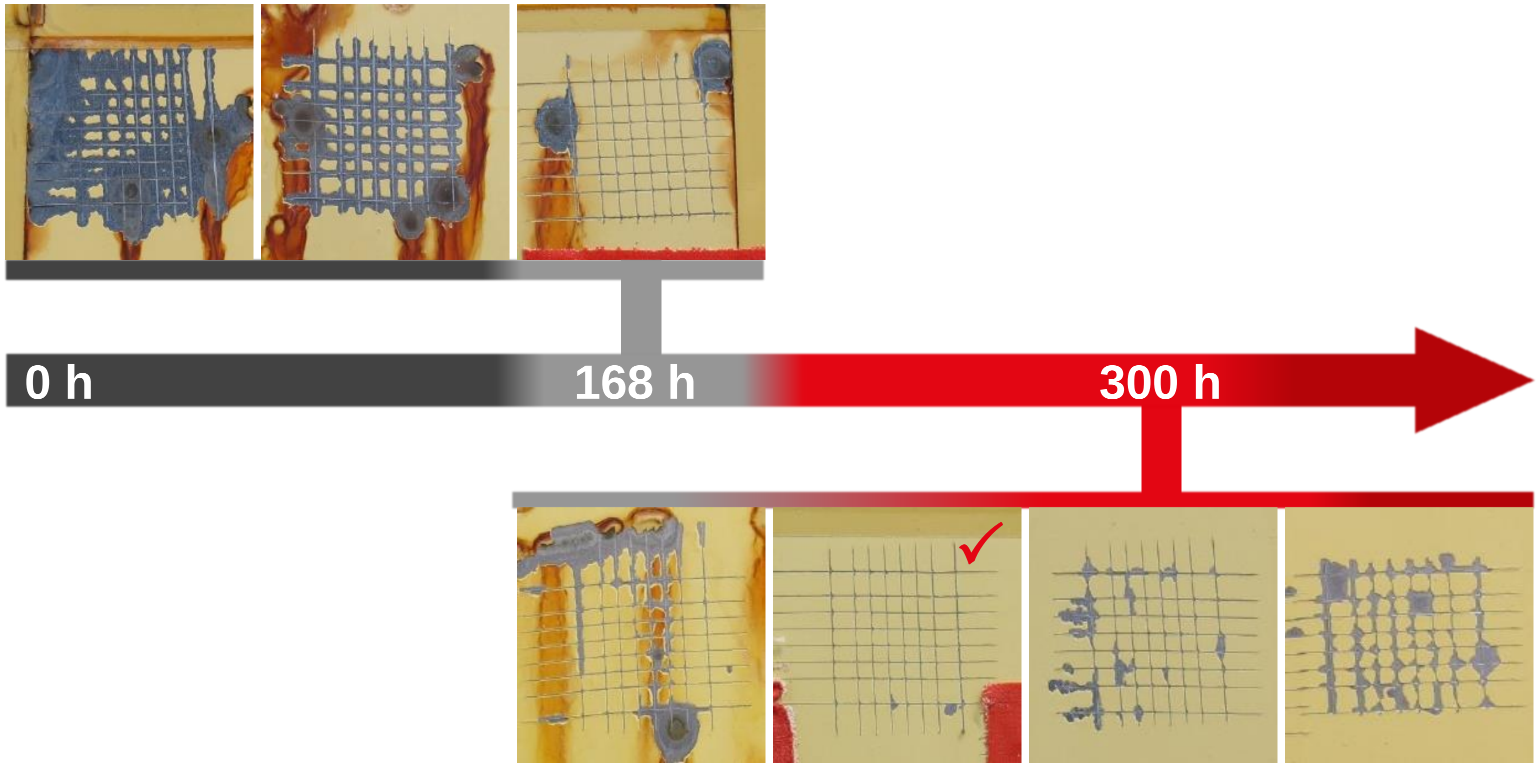


Barium sulfate ppt | Barium sulfate ppt | Barium sulfate ppt + Talc | Aktisil AM + Talc | Aktifit AM + Talc | Aktisil AM

PVC 32 % —— PVC 42 % ——

Salt Spray Test – Adhesion

24 h regeneration time: Cross-cut test 2 mm, tape tear-off

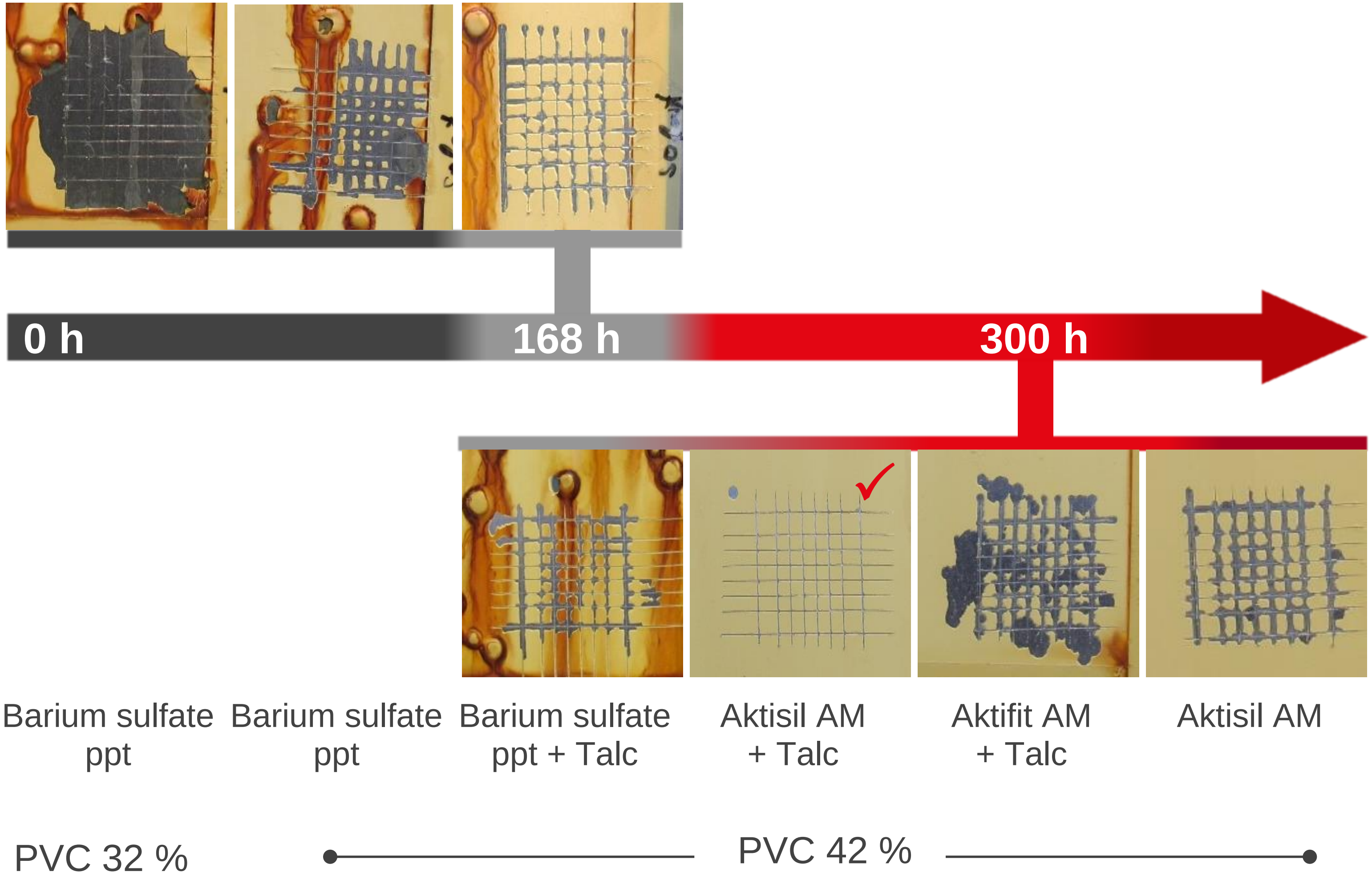


Barium sulfate ppt | Barium sulfate ppt | Barium sulfate ppt + Talc | Aktisil AM + Talc | Aktifit AM + Talc | Aktisil AM

PVC 32 % —— PVC 42 % ——

Salt Spray Test – Adhesion

without regeneration time: Cross-cut test 2 mm, tape tear-off



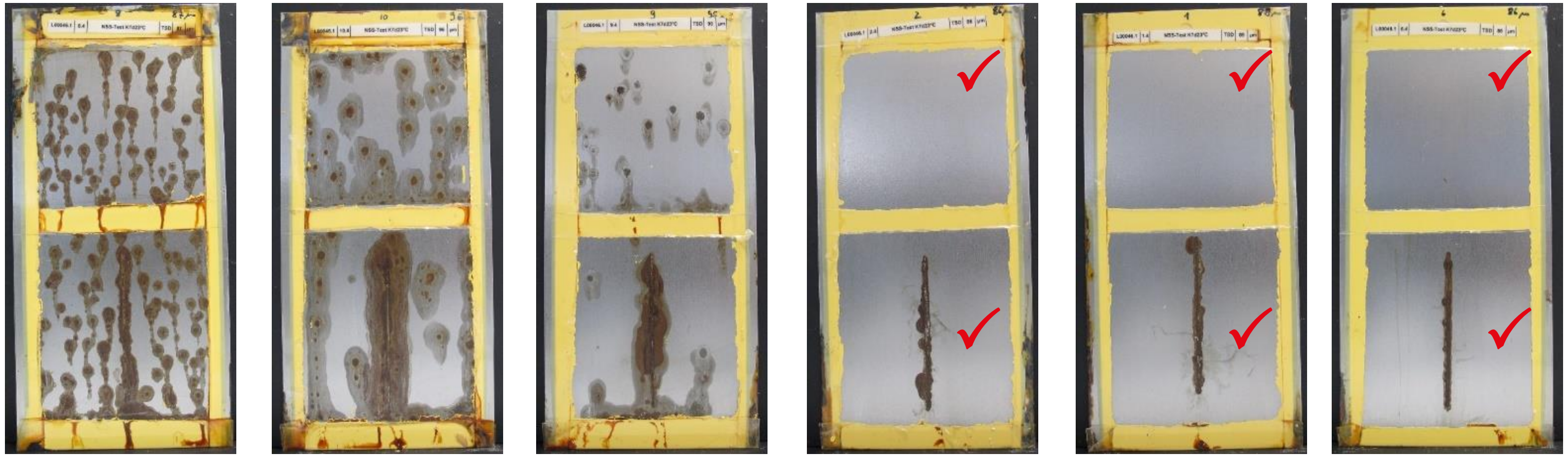
Salt Spray Test – Metall surface 300 h

24 h regeneration time:

Delamination at scribe

entirely | 10 mm | 6 mm | < 2 mm | < 2 mm | < 2 mm

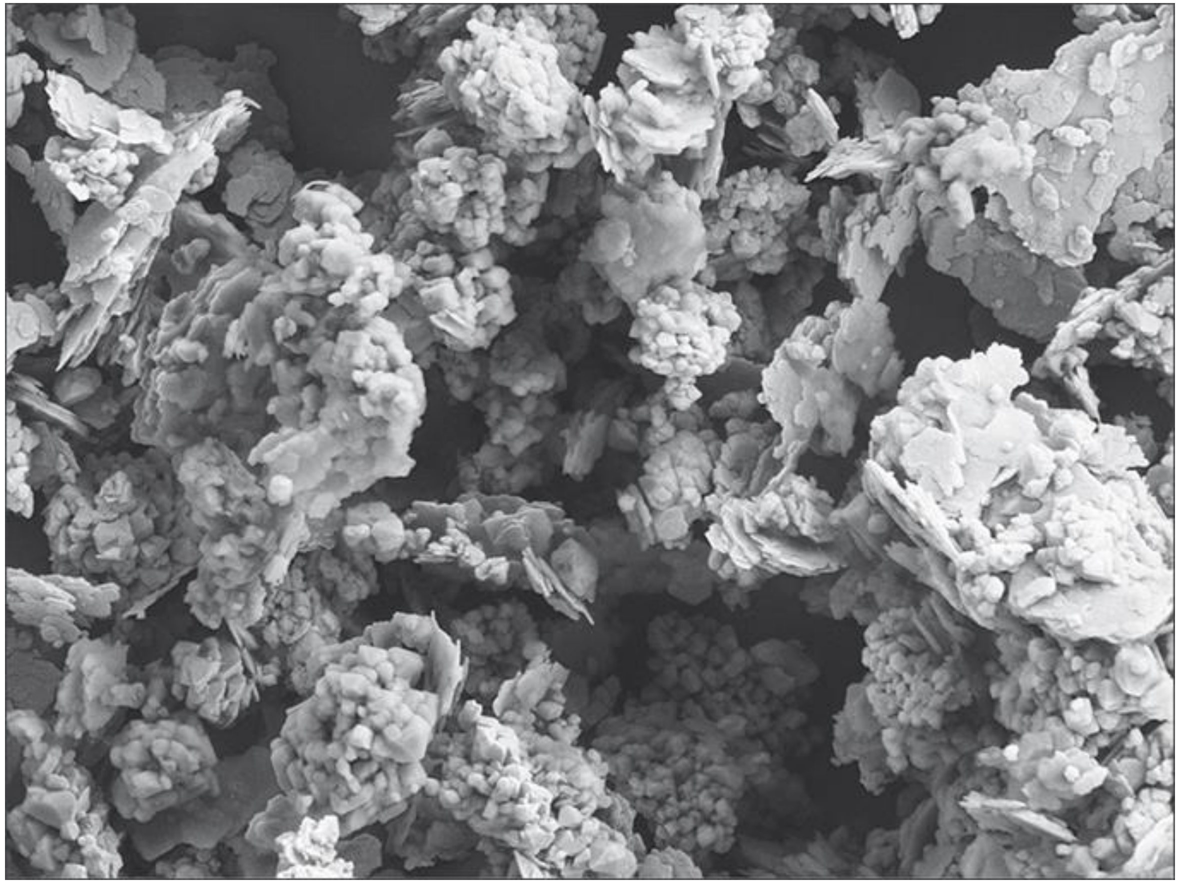
+ Coating stripped



Barium sulfate ppt | Barium sulfate ppt | Barium sulfate ppt + Talc | Aktisil AM + Talc | Aktifit AM + Talc | Aktisil AM

PVC 32 % —— PVC 42 % ——

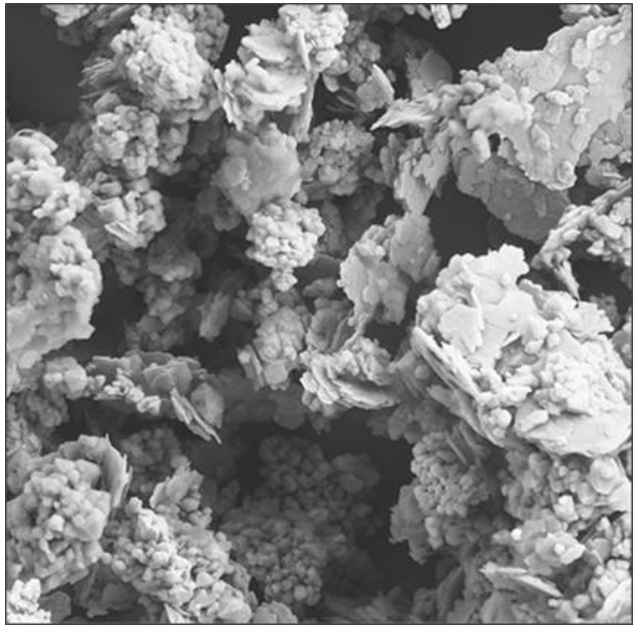
Neuburg Siliceous Earth



A natural combination of corpuscular Neuburg silica and lamellar kaolinite: a loose mixture impossible to separate by physical methods. The silica portion exhibits a round grain shape and consists of aggregated primary particles of about 200 nm diameter.

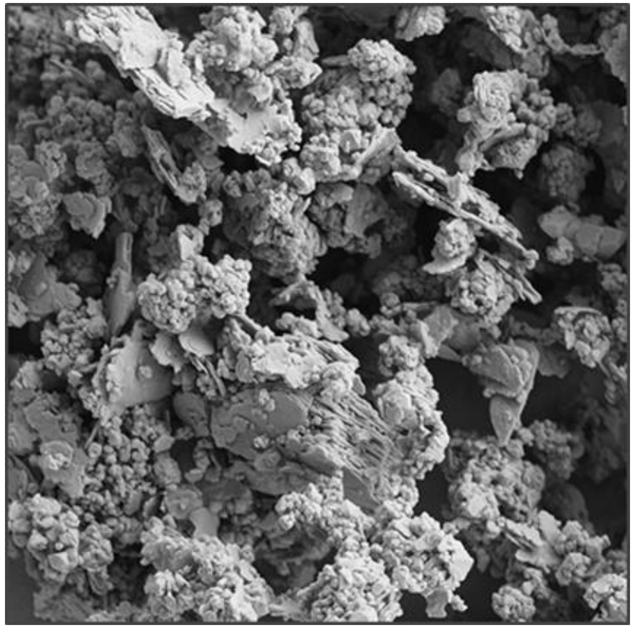
Calcined Neuburg Siliceous Earth

A downstream thermal process lead to the calcined products SILFIT and AKTIFIT, based on SILLITIN Z 86.



Neuburg Siliceous Earth

Calcination Process



Calcined Neuburg Siliceous Earth

Additional application benefits, as well as the removing of crystal water included in the kaolinite. The silica part remains inert.

Filler Characteristics

	Particle size		Oil absorption	Density	Specific surface BET	Special Features - Surface treatment
	d_{50} [µm]	d_{97} [µm]	[g/100g]	[g/cm³]	[m²/g]	
Barium sulfate ppt	0.9	3.5	22	4.4	2.7	Organic
Talc	4.4	12.5	62	2.8	8.3	-
Aktisil AM	2.2	10	45	2.6	9.0	Amino functionalized
Aktifit AM	2.0	10	65	2.6	9.0	Calcination + Amino functionalized