Silfit Z 91

in grey-colored washing machine gaskets

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Status Quo

Neuburg Siliceous Earth is used in washing machine gaskets due to its following positive effects:

- long flow time along with short cure time
- balanced ratio between tensile strength, tear resistance and compression set
- good resistance against detergents

Occasionally, problems with mold fouling may occur.

Objective

Effect of calcined Silfit Z 91 in comparison to Sillitin and a calcined clay with regard to

- compound properties with and without precipitated silica
- color of the compounds
- mold fouling caused by fillers

Base Formulation
Washing Machine Gasket

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	with silica	without silica
Vistalon 3666	175.00	175.00
Stearic Acid	1.00	1.00
Zinkoxyd aktiv	5.00	5.00
Mineral Filler	**100.00**	**150.00**
Silica (pptd., BET appr. 130 m²/g)	**25.00**	**-----**
Kronos 2222	9.00	9.00
Corax N 550/30	0.35	0.35
Aflux S	3.00	3.00
DEG	3.00	3.00
Silanogran PV	4.80	4.80
Sunpar 2280	25.00	25.00
Sulfur	0.70	0.70
Rhenogran MBT-80	2.40	2.40
Rhenogran CLD-80	1.20	1.20
Rhenocure TP/S	3.60	3.60
Total	**359.05**	**384.05**

Fillers, Characteristics

		Calcined Clay	Neuburg Siliceous Earth		
		Polestar 200 R	Sillitin N 85	Sillitin P 87	Silfit Z 91
Particle Size d_{50}	[µm]	3.6	2.3	1.1	2.0
Particle Size d_{97}	[µm]	19	12	4.3	10
Oil Absorption	[g/100g]	60	47	53	59
Specific Surface Area BET	[m²/g]	6.5	10	12	7.6
Calcination		yes	none	none	yes

Preparation and Curing of the Compound

- **Mixing**

  Open mill Ø 150 x 300 mm

  Batch volume: approx. 750 cm³

  Temperature: 50 °C

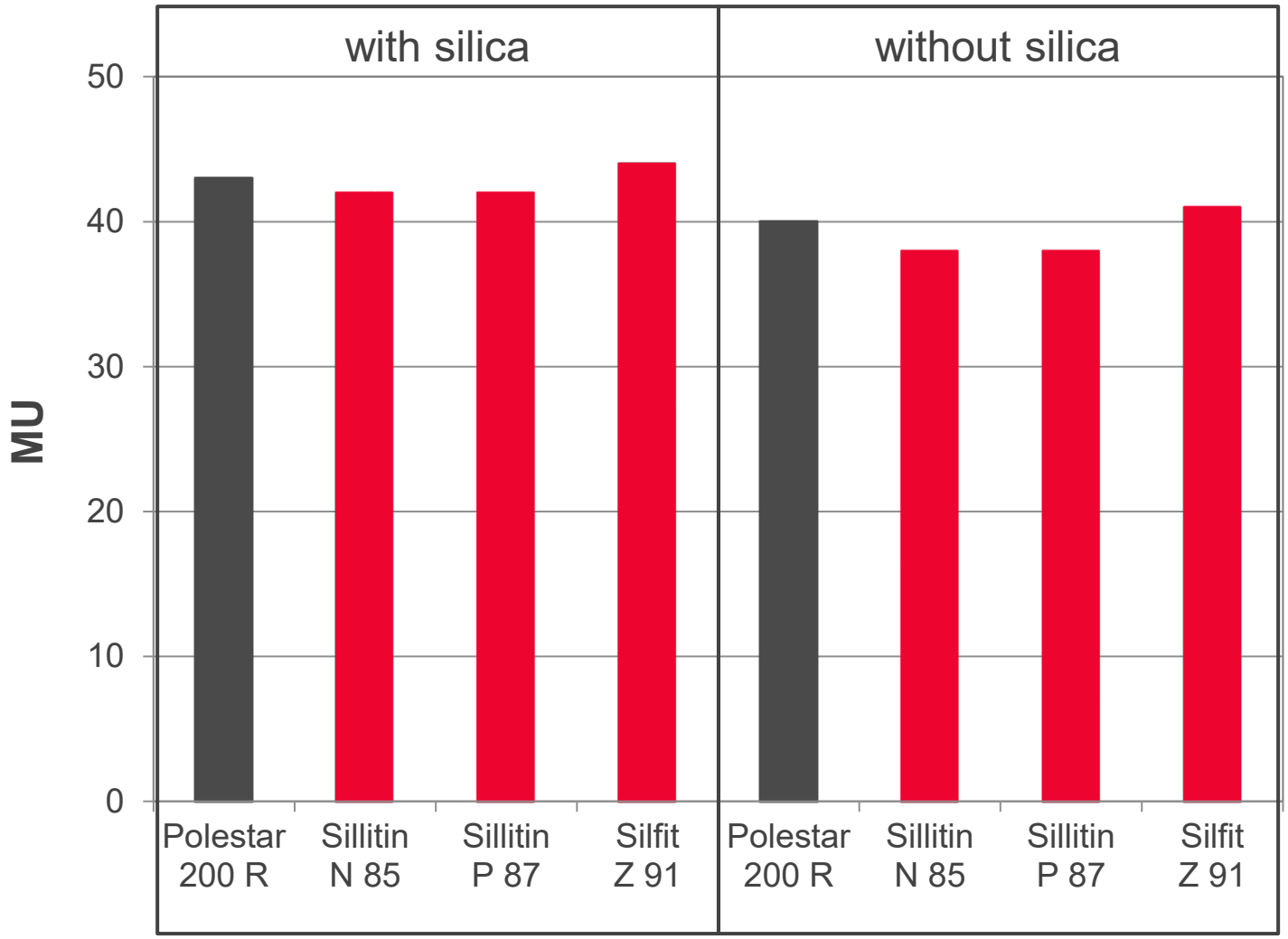
  Mixing time: approx. 15 min.

- **Curing**

  Press, 180 °C, 5 min.

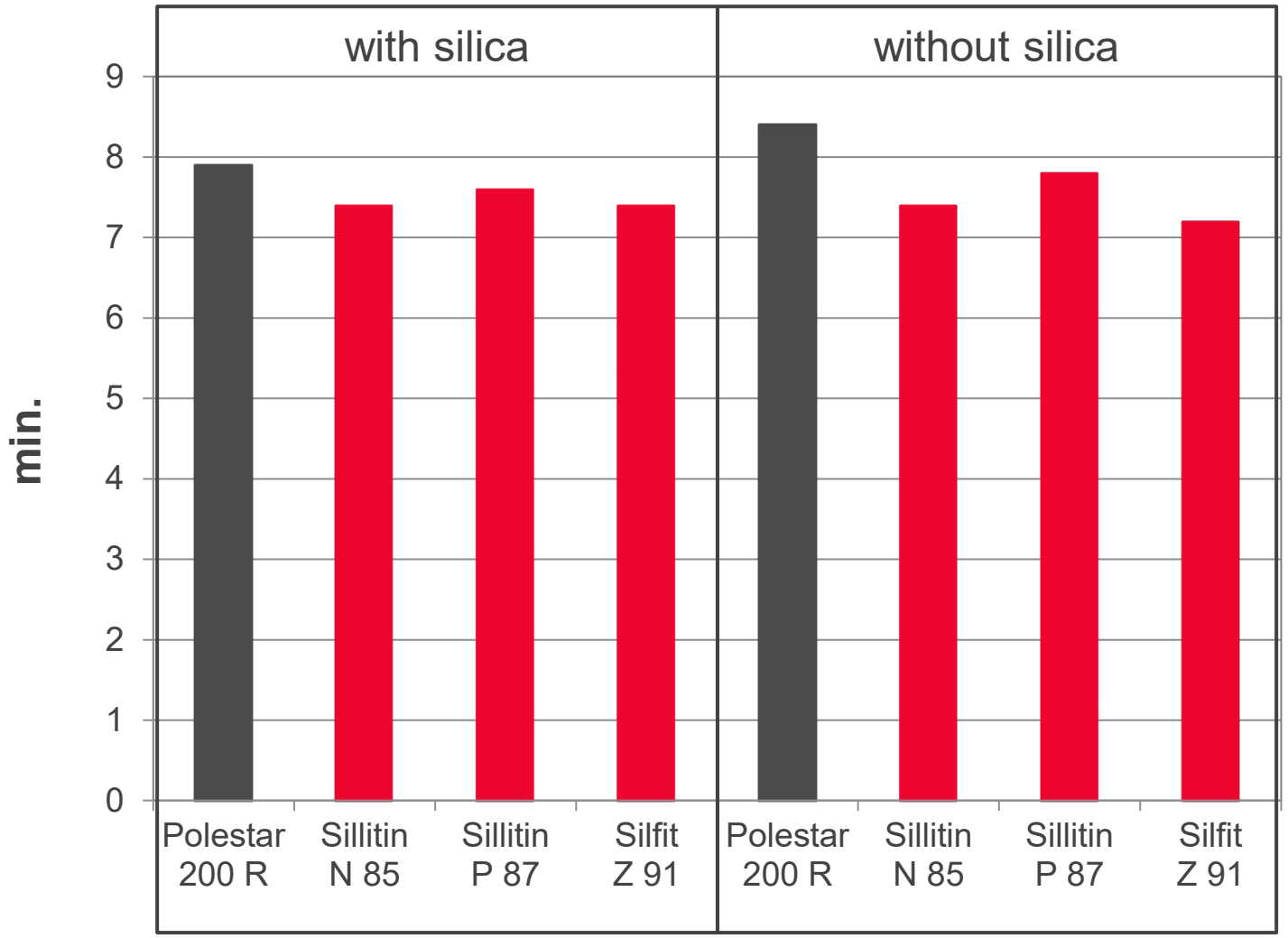
Mooney Viscosity

DIN 53 523 Part 3, ML 1+4, 120 °C



Mooney Scorch Time

DIN 53 523 Part 4, ML +5, 120 °C



Torque Maximum

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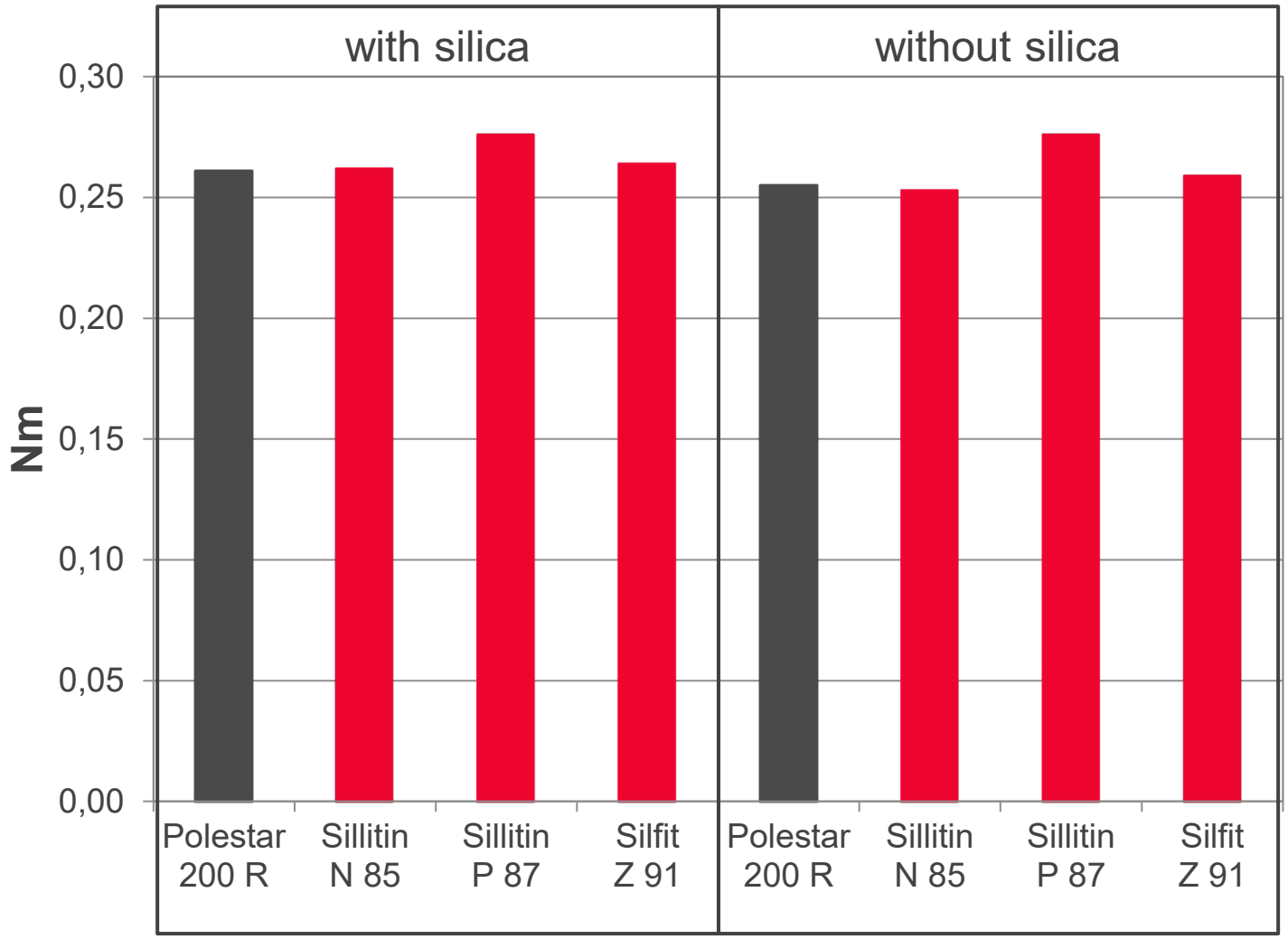
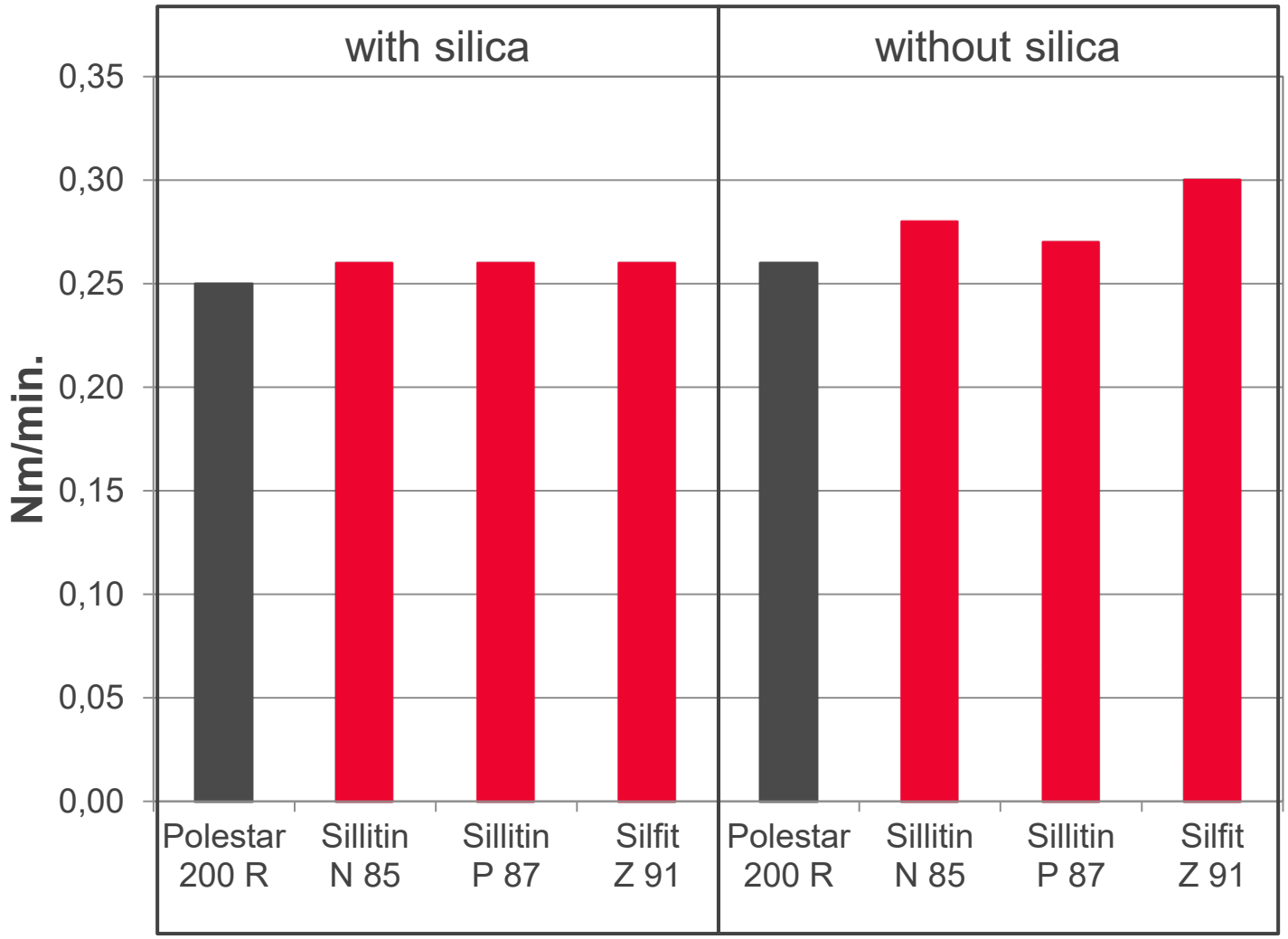
DIN 53 529-A3, 180 °C, 0,2° deflection – Göttfert Elastograph



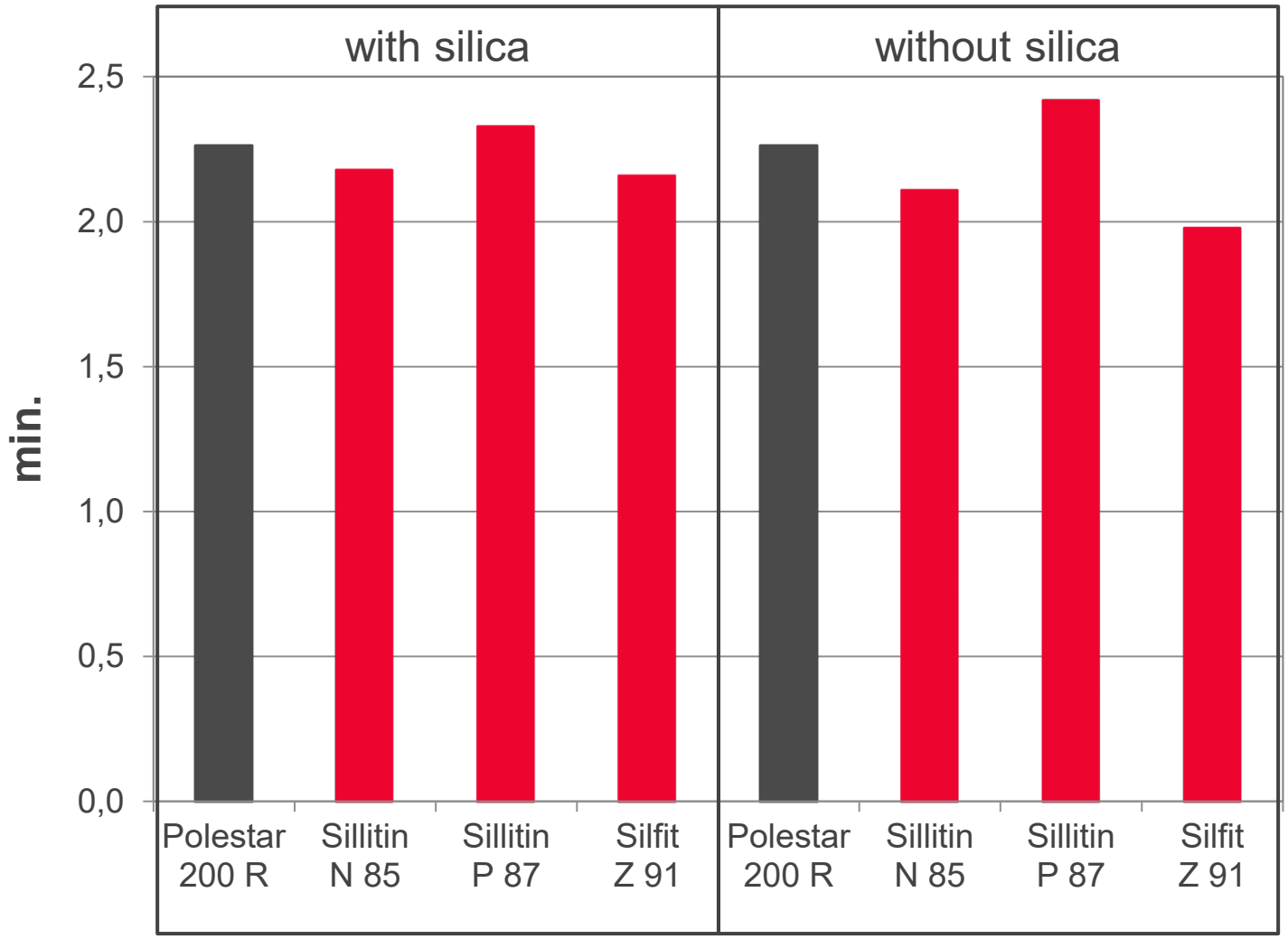
Maximum Cure Rate

DIN 53 529-A3, 180 °C, 0,2° deflection – Göttfert Elastograph



Conversion Time t_{90}

DIN 53 529-A3, 180 °C, 0,2° deflection – Göttfert Elastograph



Hardness

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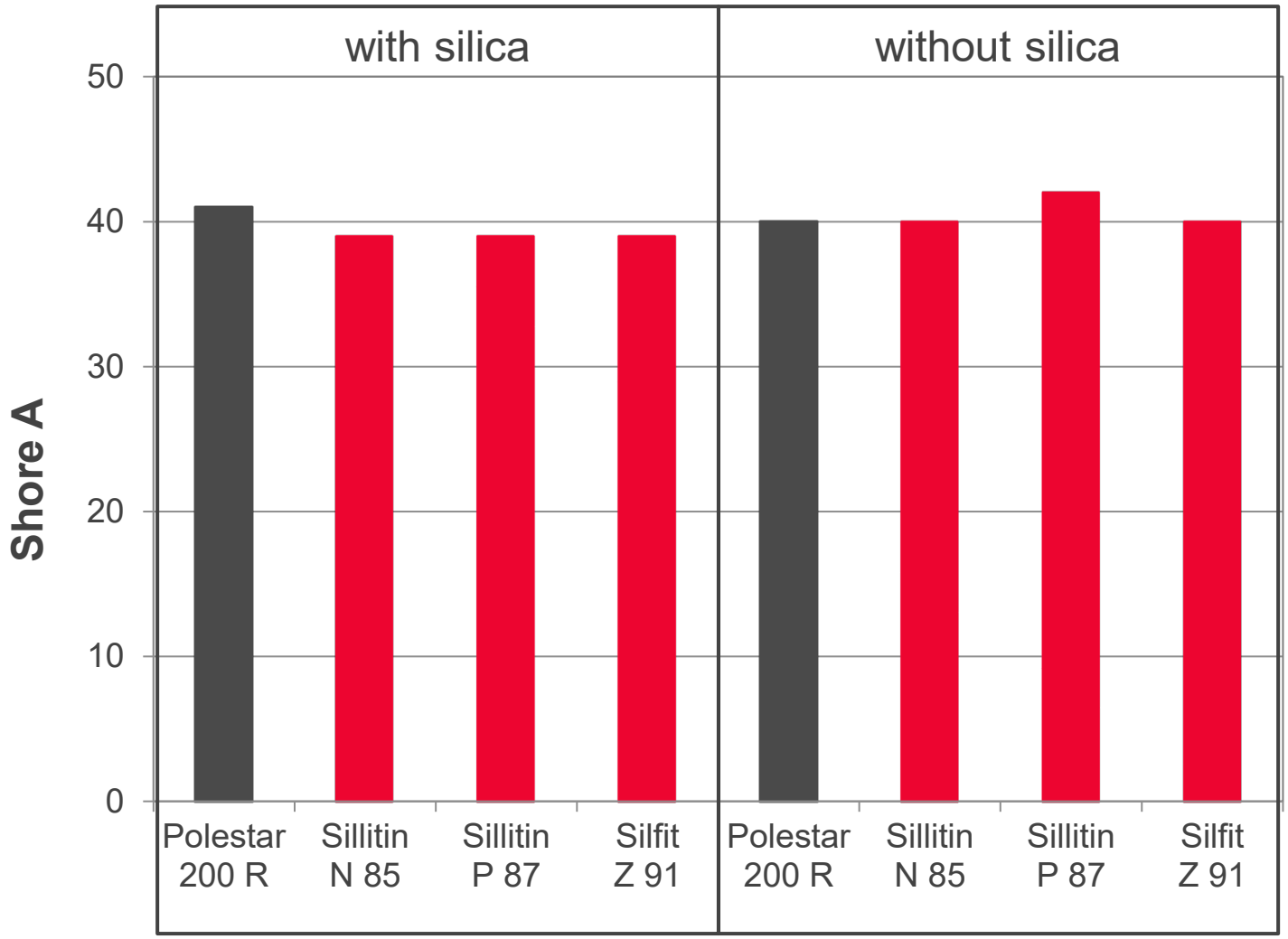
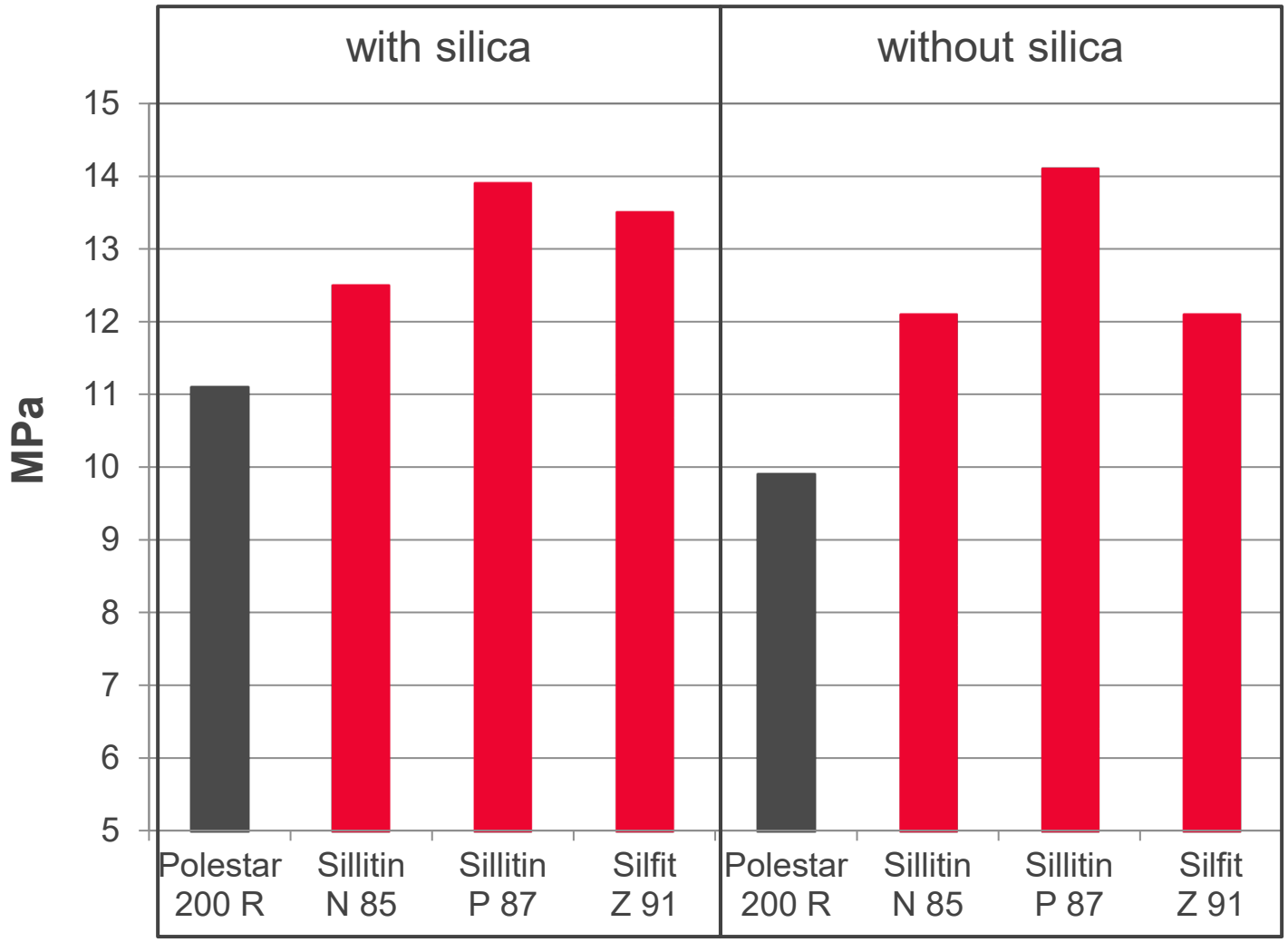
DIN 53 505-A, piled-up S2 dumbbells



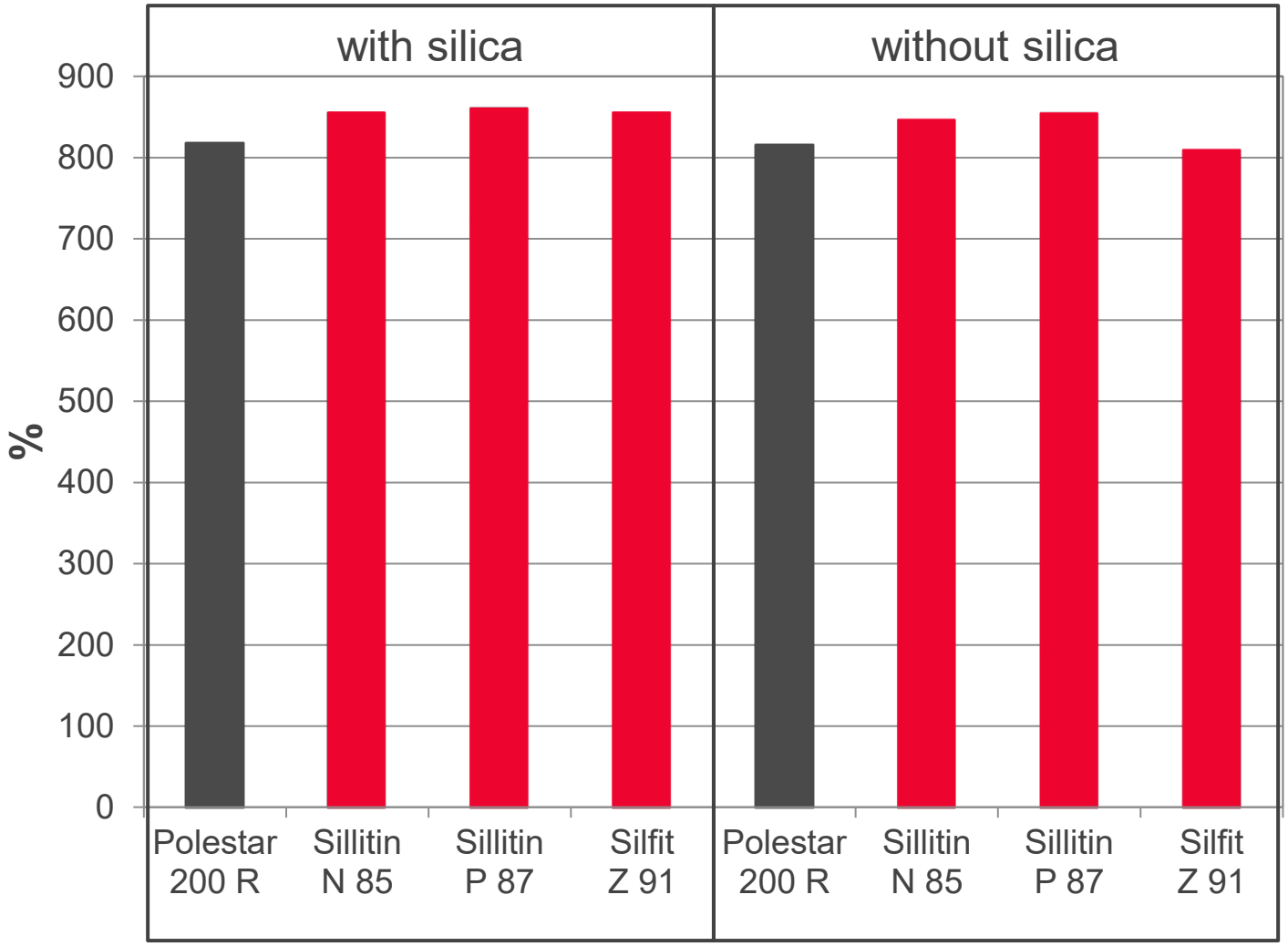
Tensile Strength

DIN 53 504, S2



Elongation at Break

DIN 53 504, S2



Moduli

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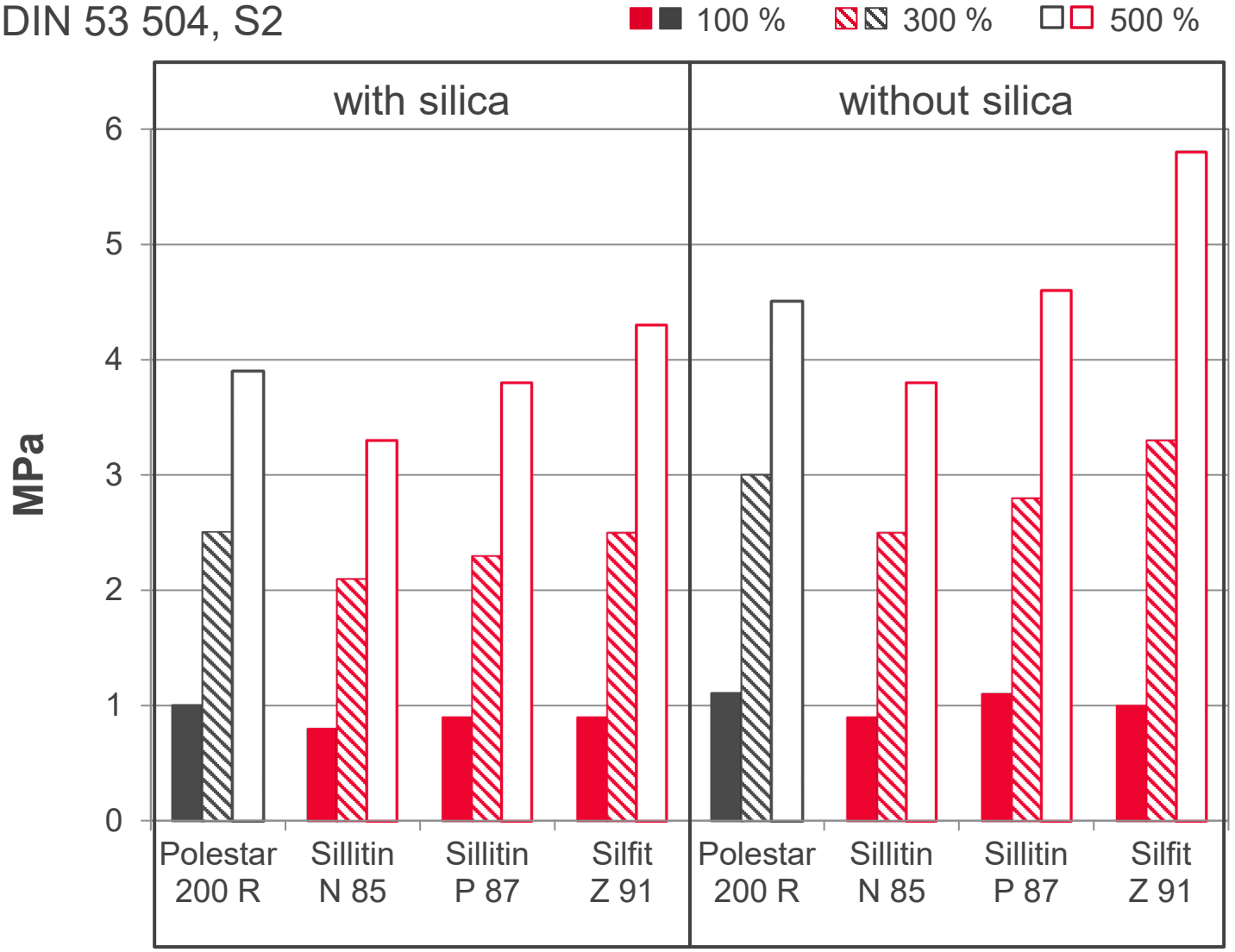
DIN 53 504, S2



Tear Resistance

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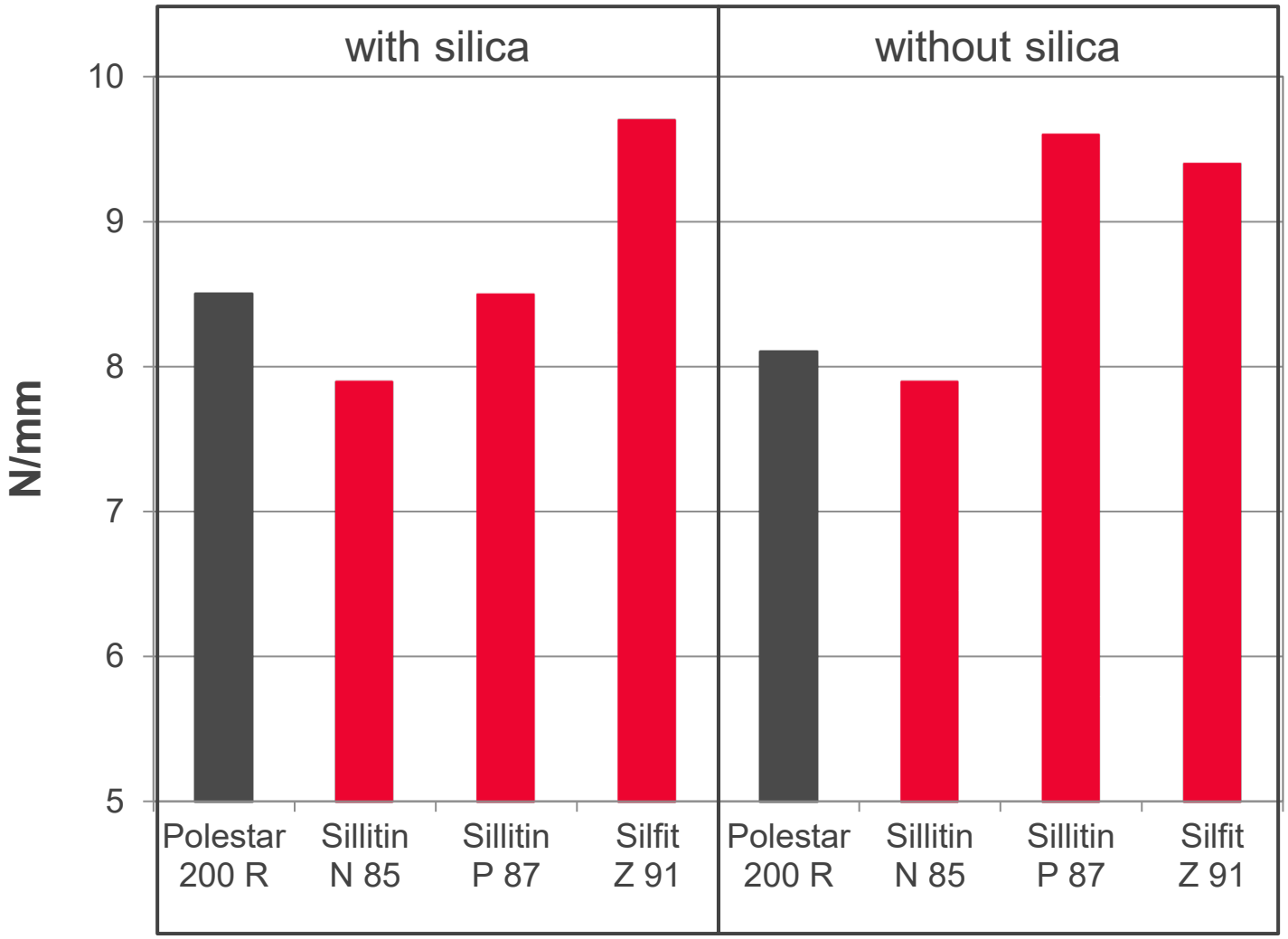
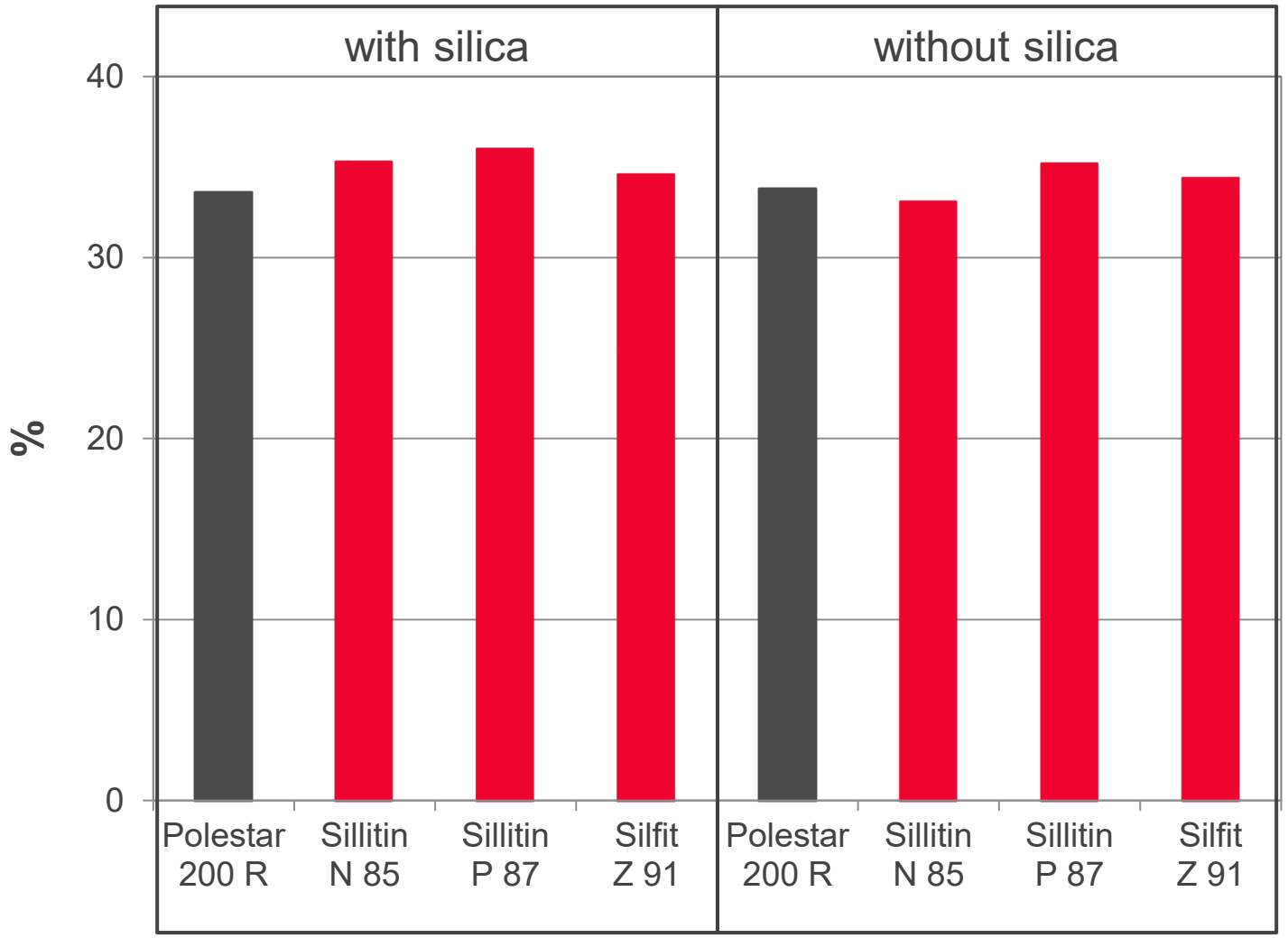
DIN ISO 34-1, trouser specimen



Compression Set

DIN ISO 815-1 B, cooling method A, 24 h / 100°C



Immersion in Detergent
Remaining Hardness

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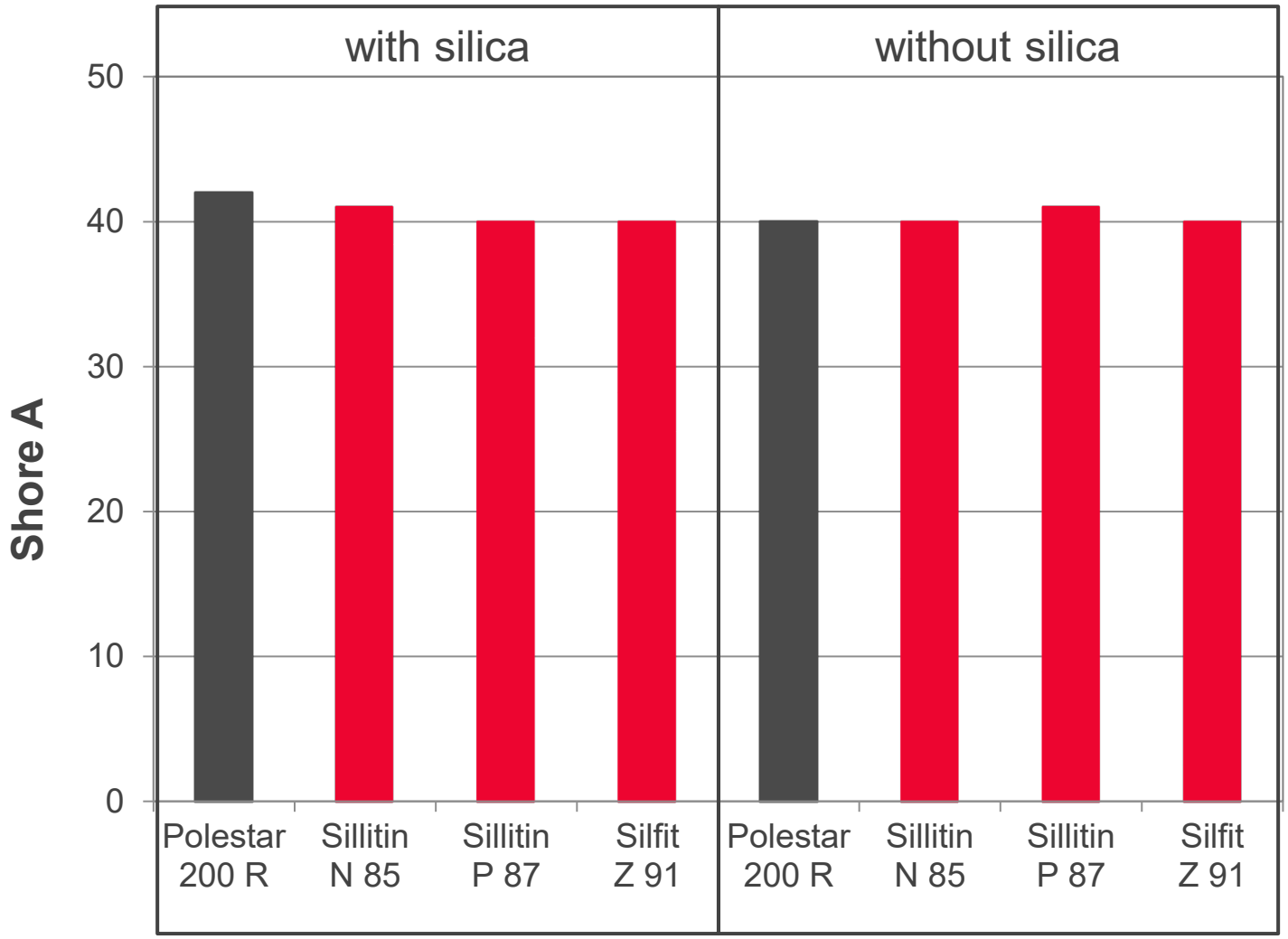
2 % Persil in tap water, 100 h / 100 °C



Immersion in Detergent
Remaining Tensile Strength

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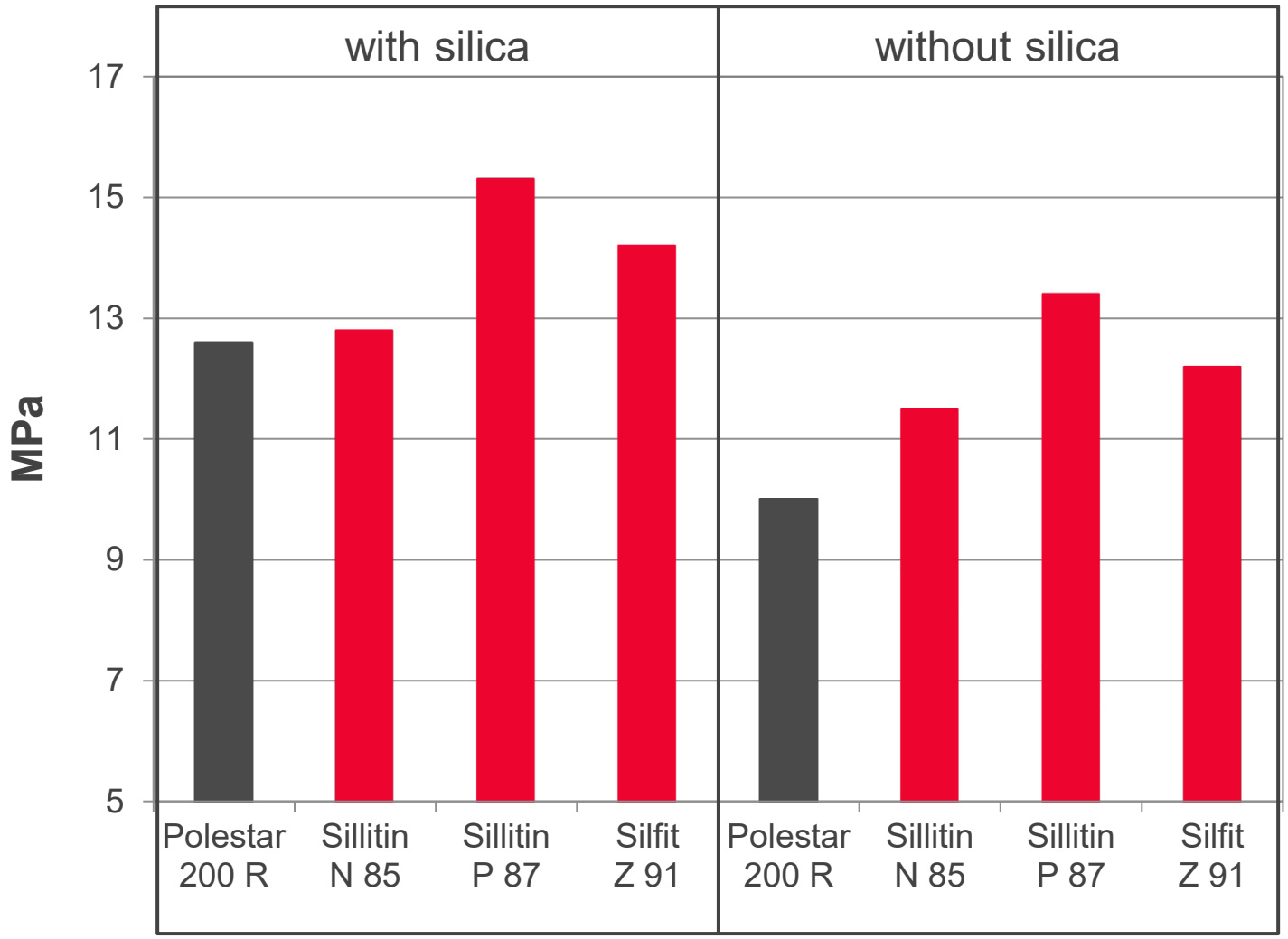
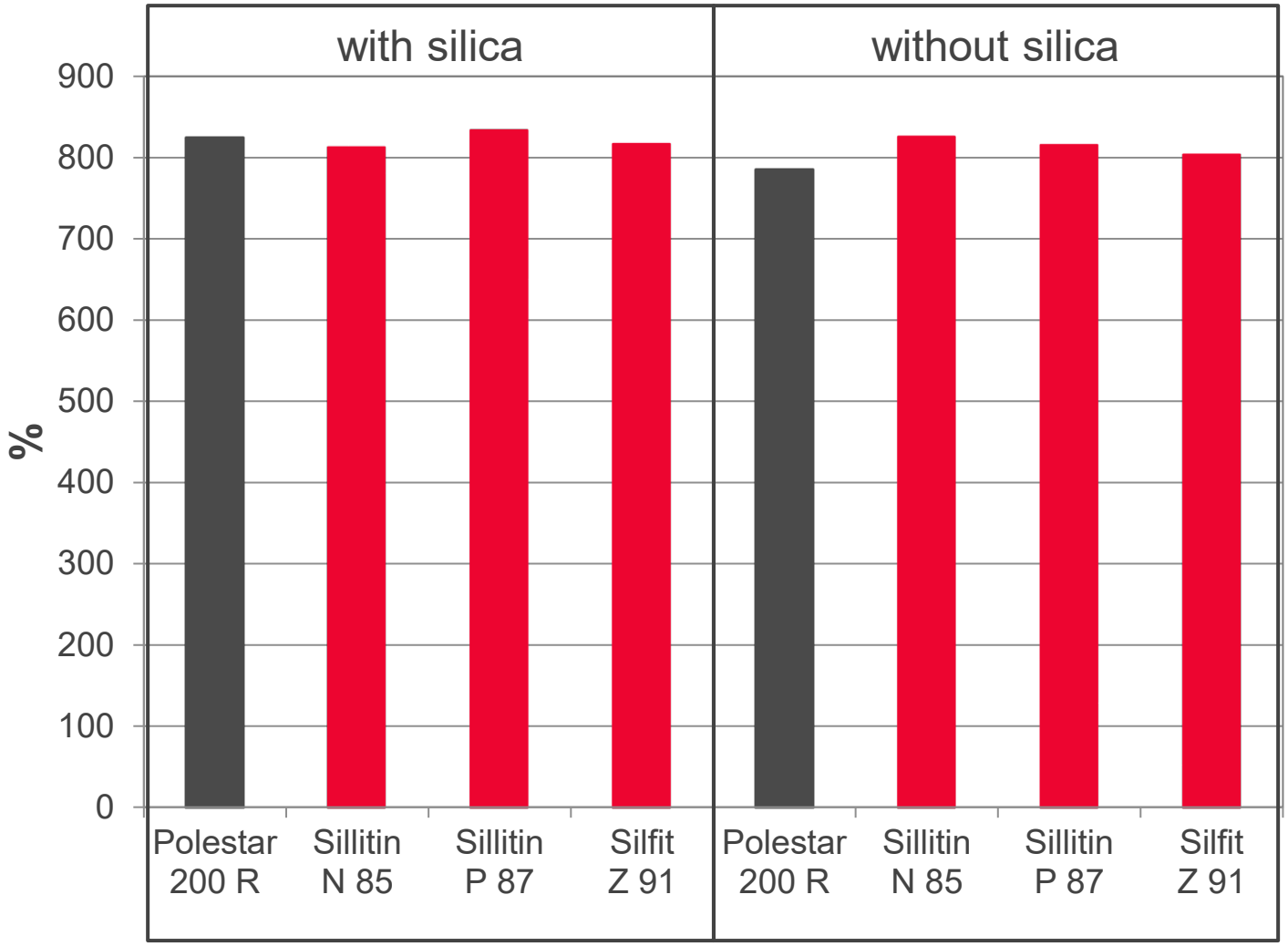
2 % Persil in tap water, 100 h / 100 °C



Immersion in Detergent
Remaining Elongation at Break

HOFFMANN MINERAL

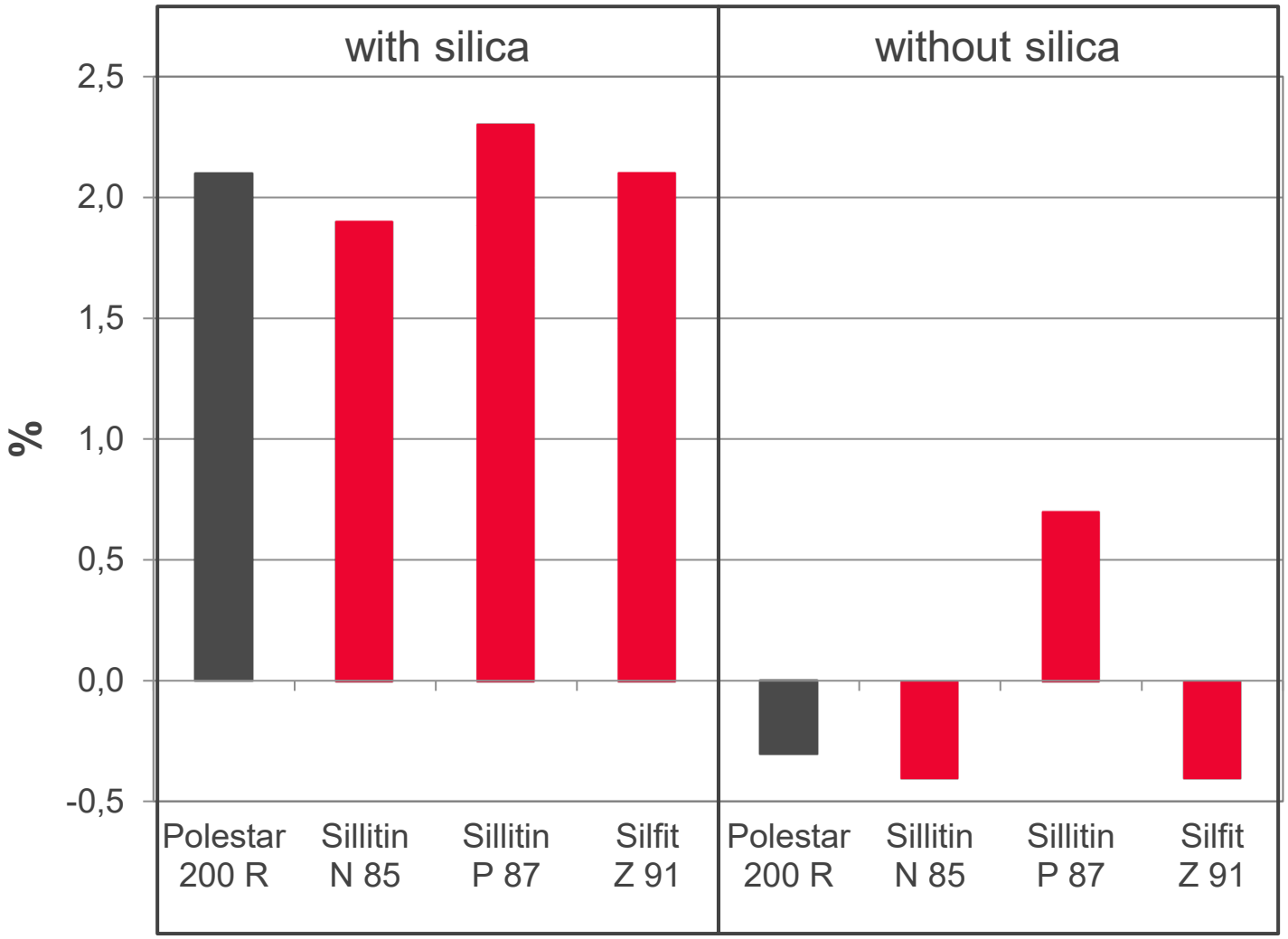
2 % Persil in tap water, 100 h / 100 °C



Immersion in Detergent
Change of Volume

HOFFMANN MINERAL

2 % Persil in tap water, 100 h / 100 °C



Hot Air Aging

After hot air aging (DIN 53 508,168 h / 120 °C) no significant differences between the fillers can be observed.

Typical results:

Change of tensile strength:	- 40 %
Change of elongation at break:	- 40 %
Change of hardness:	+9 Shore A

For that reason the single properties are not shown here.

Color Values

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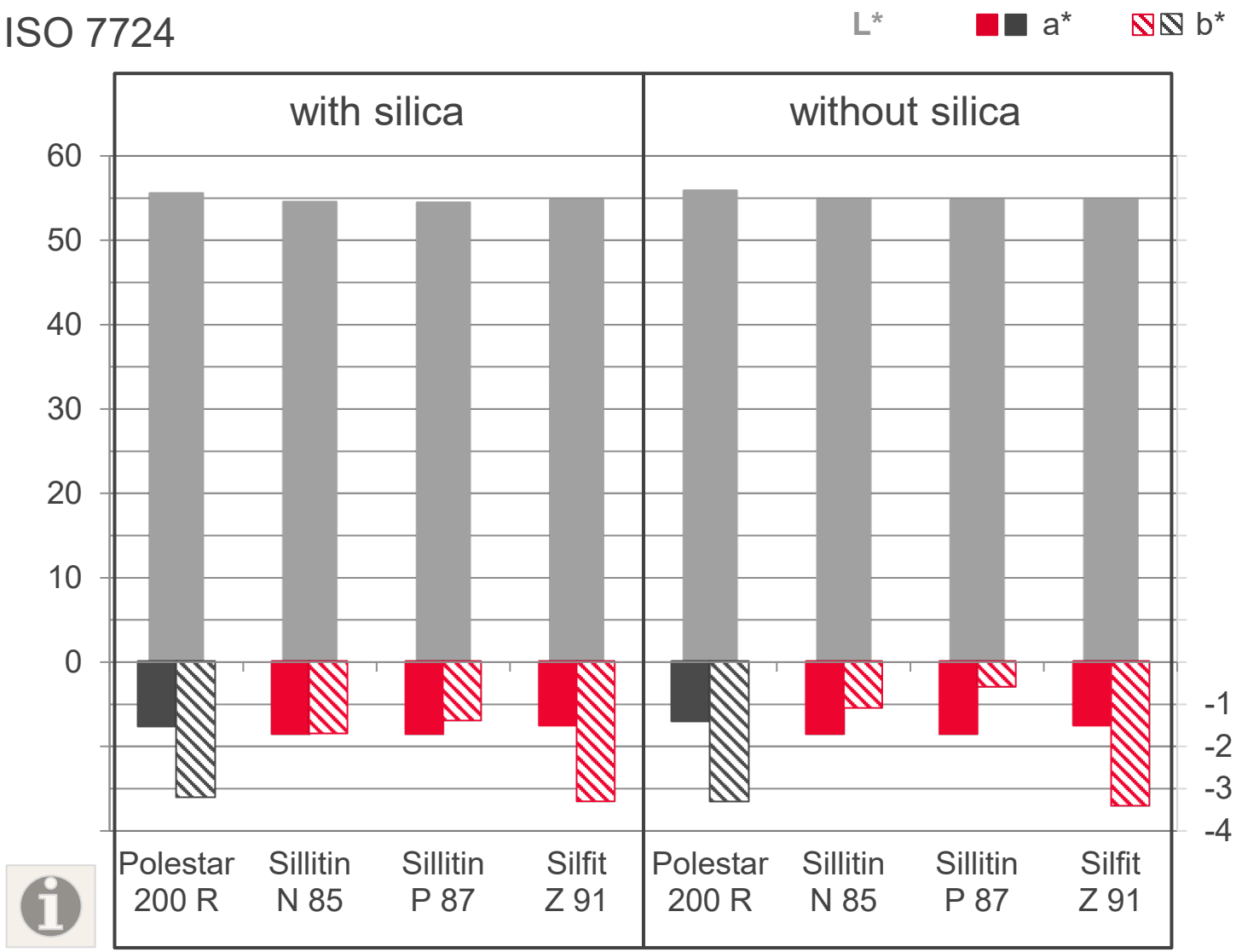
ISO 7724



Color
Conclusion

Silfit Z 91 leads to

- a lower yellowish tint than Sillitin (detectable by a higher blue tint), especially without silica.
- a color effect comparable to calcined clay.

Thus, compared to Sillitin, with Silfit Z 91 it should be possible to reduce the loading of titaniumdioxide and carbon black without any loss regarding color.

This is shown in the following chart in comparison to Sillitin P 87.

Silfit Z 91 with different TiO_2 and CB loadings

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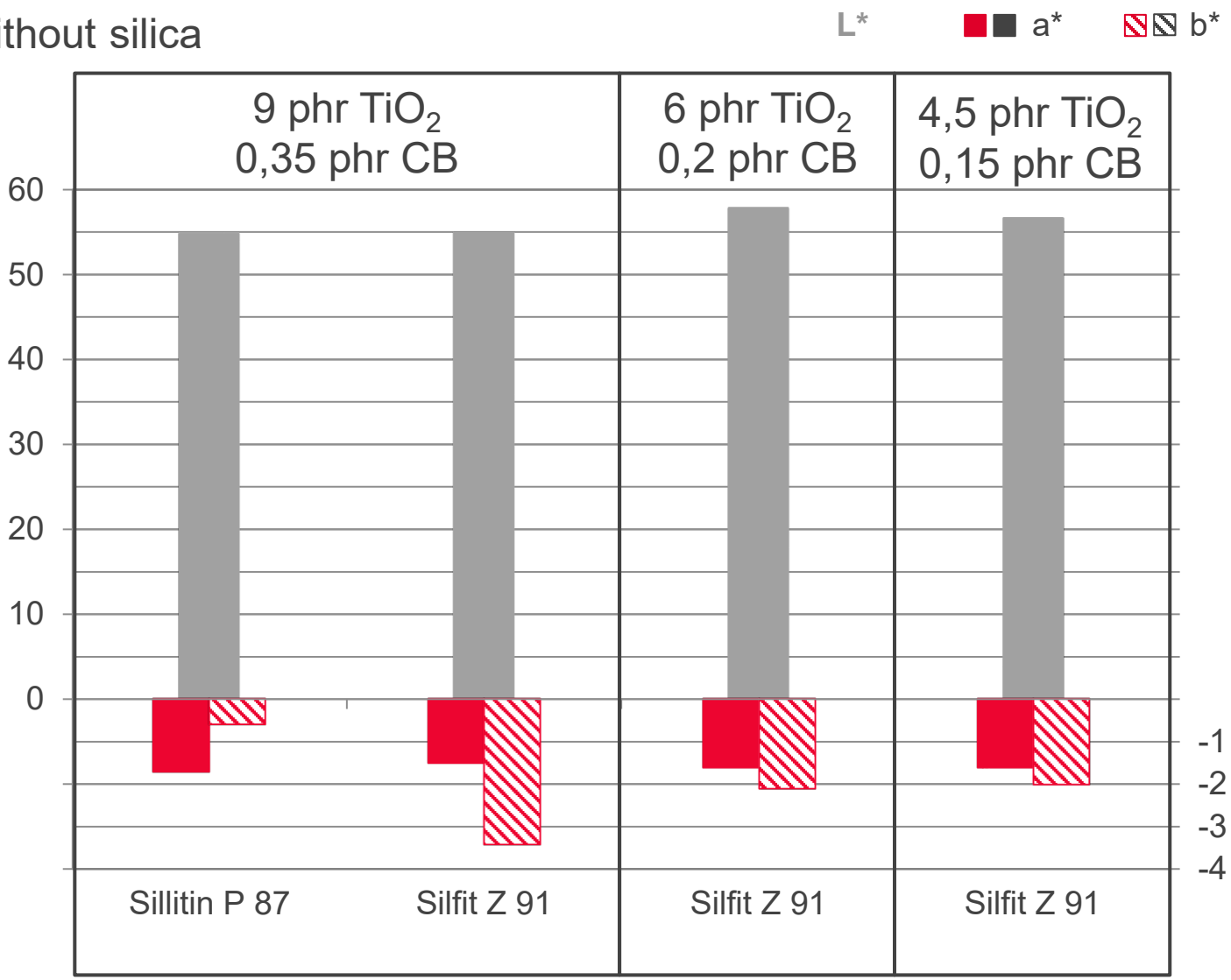
without silica

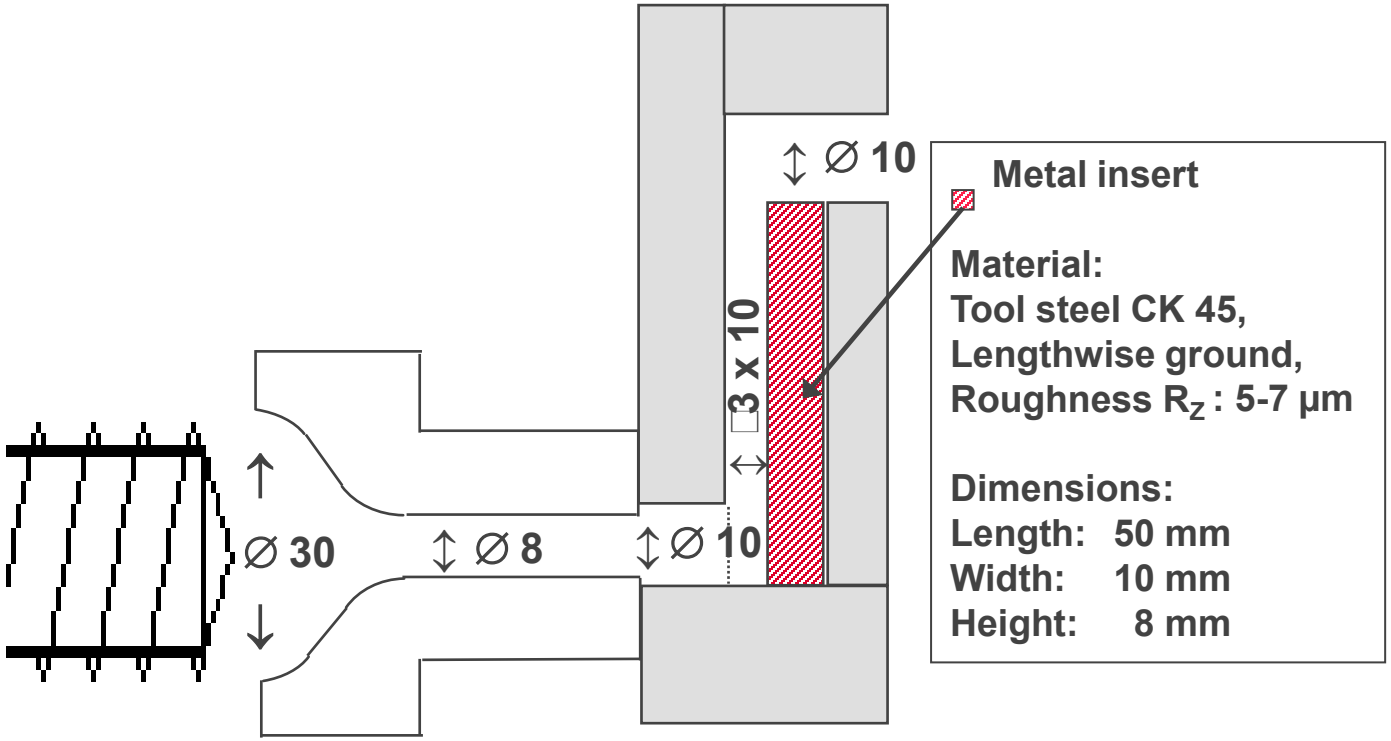


Mold Fouling

Mold fouling or die plating caused by fillers can be observed in extrusion processes as well as in flow channels and at the die orifice of extruders.

The following test set-up with a measuring device applied on the extruder was used to detect the tendency to cause deposits respectively the tendency to give rise to die plating or mold fouling.

Measuring Device

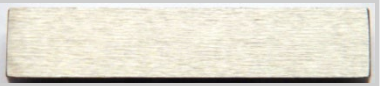


all dimensions in mm

Experimental Parameters

Extruder		Schwabenthan Polytest 30 R
Screw diameter	mm	30
Process length	mm	450
Temperature set point head / zone 1 / zone 2	°C	60 / 60 / 60
Cooling (zone 1 and 2)		¼ turn open
Screw speed	rpm	100
Measuring channel l x w x h	mm	50 x 10 x 3
Metal insert material		Tool steel CK 45, lengthwise ground
Metal insert roughness R_z (across the flow direction)	µm	5-7
Feed strips	mm	30 x 6

Deposits on the Metal Insert

	Sillitin N 85	Sillitin P 87	Silfit Z 91
			
extruded amount [kg]	2.5	2.5	5
throughput [g/min.]	388	404	454

Conclusion

The calcined Silfit Z 91 offers the following benefits:

- General properties between Sillitin N 85 and Sillitin P 87.
- Increase of cure speed and short conversion time t_{90} without silica.
- Higher tensile strength and higher tear resistance than calcined clay, especially without silica.
- Replacement of precipitated silica without negatively affecting properties, tensile strength and tear resistance even better than calcined clay combined with silica.
- Immersion in detergent has no negative effect on hardness, tensile strength or elongation at break; thus, the benefits of Silfit Z 91 are remaining; additionally, less change in volume after replacement of precipitated silica.
- Very bright and neutral color enables lower titanium dioxide and carbon black loading in comparison to Sillitin. Prevention of filler induced mold fouling during the injection.

We supply material for good ideas!

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