Partial titanium dioxide replacement by Calcined Neuburg Siliceous Earth in 2C PU top coat white

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Status Quo

Titanium dioxide is probably the most important white pigment for bright, decorative applications. No other white pigment can achieve a comparable hiding power at the same concentration.

Nevertheless, due to fluctuating delivery reliability, labeling requirements and prices that are difficult to calculate, possible alternatives are sought or the concentration in the coatings is reduced as far as possible.

Objective

The objective of this investigation is to show how a part of the titanium dioxide can be replaced by calcined Neuburg Siliceous Earth while maintaining the same properties.

Two products were selected from the series of calcined Neuburg Siliceous Earth, which are especially suitable for white applications due to their high brightness.

Silfit Z 91 is the calcined grade of natural Neuburg Siliceous Earth, which is used as standard for titanium dioxide replacement due to its high brightness and color neutrality.

Aktifit PF 111 is produced by modifying the surface with an alkyl functional group, based on Silfit Z 91, which is additionally hydrophobic and can offer rheology control as an additional function.

Base Formulation

			Control
Component A	Desmophen 680 BA	Polyesterpolyol	35.38
	Borchi Gol OL 31	Surface additive	0.73
	Byk 141	Defoamer	0.37
	Tinuvin 292 (50% in Xylene)	Light stabilizer	0.73
	Dabco 33-LV (10% in Butyl acetate)	Catalyst	3.71
	Bentone 38 (10% in Solvent Naphta 100 : Anti Terra U = 85:5)	Rheology additive	2.60
	Disperbyk 118	Dispersing agent	0.74
	Aerosil R 972	**Rheology additive, hydrophobic, fumed silica**	**0.18**
	Titanium dioxide	**Pigment, rutile**	**29.60**
	Methoxypropylacetate / Butyl acetate 1:1	Solvent	14.39
Comp. B	Desmodur ultra N 3390 BA	Polyisocyanate	9.83
	Methoxypropylacetate	Solvent	1.74
Total			**100.00 %**

Formulation Variants

Aerosil R 972	**Rheology additive**	**0.18**
Titanium dioxide	**Pigment, rutile**	**29.60**

+ Calcined Neuburg Siliceous Earth

	equal weight			equal volume
	- 10 % TiO_2	- 20 % TiO_2		- 30 % TiO_2
			without hydrophobic silica	
Aerosil R 972	0.18	0.18	-	-
Titanium dioxide	26.64	23.68	23.68	20.72
Silfit Z 91	2.96	5.92	-	-
Aktifit PF 111	-	-	5.92	5.63

Formulation Variants
Parts by weight

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		- 10 % TiO_2 equal weight Silfit Z 91	- 20 % TiO_2 equal weight Silfit Z 91	- 20 % TiO_2 equal weight Aktifit PF 111	- 30 % TiO_2 equal volume Aktifit PF 111
Component A	Desmophen 680 BA	35.38	35.38	35.38	35.38
	Borchi Gol OL 31	0.73	0.73	0.73	0.73
	Byk 141	0.37	0.37	0.37	0.37
	Tinuvin 292 (50% in Xylene)	0.73	0.73	0.73	0.73
	Dabco 33-LV (10% in Butyl acetate)	3.71	3.71	3.71	3.71
	Bentone 38 (10% in Solvent Naphta 100 / Anti Terra U = 85:5)	2.60	2.60	2.60	2.60
	Disperbyk 118	0.74	0.74	0.74	0.66
	Aerosil R 972	0.18	0.18		
	Titanium dioxide	26.64	23.68	23.68	20.72
	Silfit Z 91	2.96	5.92		
	Aktifit PF 111			5.92	5.63
	Methoxypropylacetate / Butyl acetate 1:1	14.39	14.39	14.39	14.39
Comp. B	Desmodur ultra N 3390 BA	9.83	9.83	9.83	9.83
	Methoxypropylacetate	1.74	1.74	1.74	1.74
Total		**100**	**100**	**99.82**	**96.49**

Formulation Variants to 100 %

		- 10 % TiO_2 equal weight Silfit Z 91	- 20 % TiO_2 equal weight Silfit Z 91	- 20 % TiO_2 equal weight Aktifit PF 111	- 30 % TiO_2 equal volume Aktifit PF 111
Component A	Desmophen 680 BA	35.38	35.38	35.45	36.67
	Borchi Gol OL 31	0.73	0.73	0.73	0.76
	Byk 141	0.37	0.37	0.37	0.38
	Tinuvin 292 (50% in Xylene)	0.73	0.73	0.73	0.76
	Dabco 33-LV (10% in Butyl acetate)	3.71	3.71	3.72	3.85
	Bentone 38 (10% in Solvent Naphta 100 / Anti Terra U = 85:5)	2.60	2.60	2.60	2.69
	Disperbyk 118	0.74	0.74	0.74	0.68
	Aerosil R 972	0.18	0.18		
	Titanium dioxide	26.64	23.68	23.72	21.47
	Silfit Z 91	2.96	5.92		
	Aktifit PF 111			5.93	5.84
	Methoxypropylacetate / Butyl acetate 1:1	14.39	14.39	14.42	14.91
Comp. B	Desmodur ultra N 3390 BA	9.83	9.83	9.85	10.19
	Methoxypropylacetate	1.74	1.74	1.74	1.80
Total		**100.00 %**	**100.00 %**	**100.00 %**	**100.00 %**

Filler Characteristics

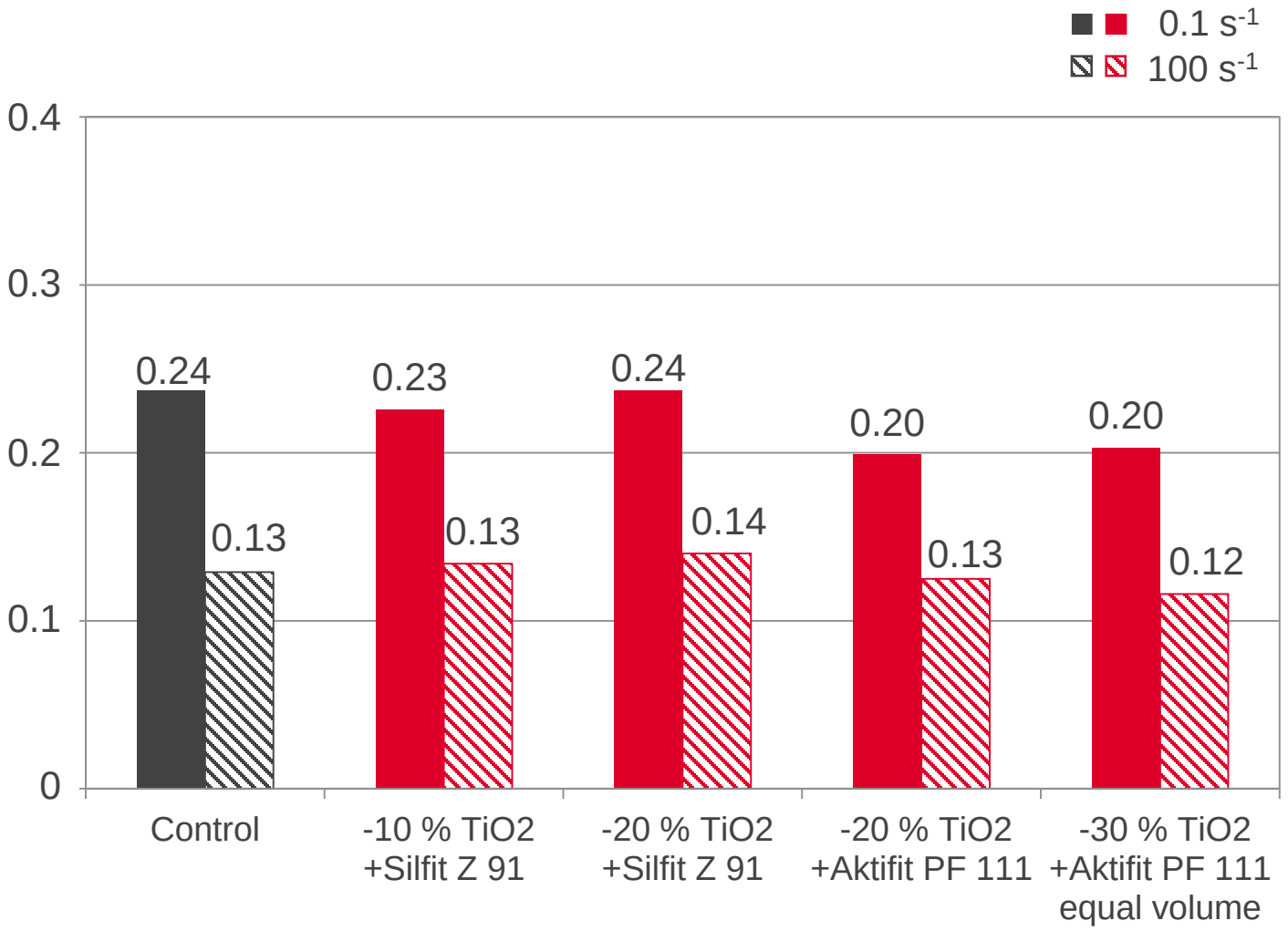
	Titanium dioxide	Silfit Z 91	Aktifit PF 111
Color L*	98.1	95	94
Color a*	-0.3	-0.1	-0.2
Color b*	2.6	1	1
Particle size d_{50} [µm]	0.2	2	2
Particle size d_{97} [µm]	0.8	10	10
Density [g/cm³]	4.1	2.6	2.6
Surface treatment	Al_2O_3, SiO_2, ZrO_2 treatment	---	alkyl functionalized, hydrophobic

Preparative Methods

Mixing	Grinding with glass beads at the dissolver with adapted bead mill: 10 min at 4,7 m/s
Application	After 14 days of maturing Substrate: cold rolled steel, Q-Panel Typ R 48 Doctor blade: gap 360 µm Dry film thickness: ~ 120 µm, or as indicated
Conditioning	Drying conditions 2 days at 23 °C / 50 % relative humidity

Viscosity

after 28 d, [Pa·s]



Color

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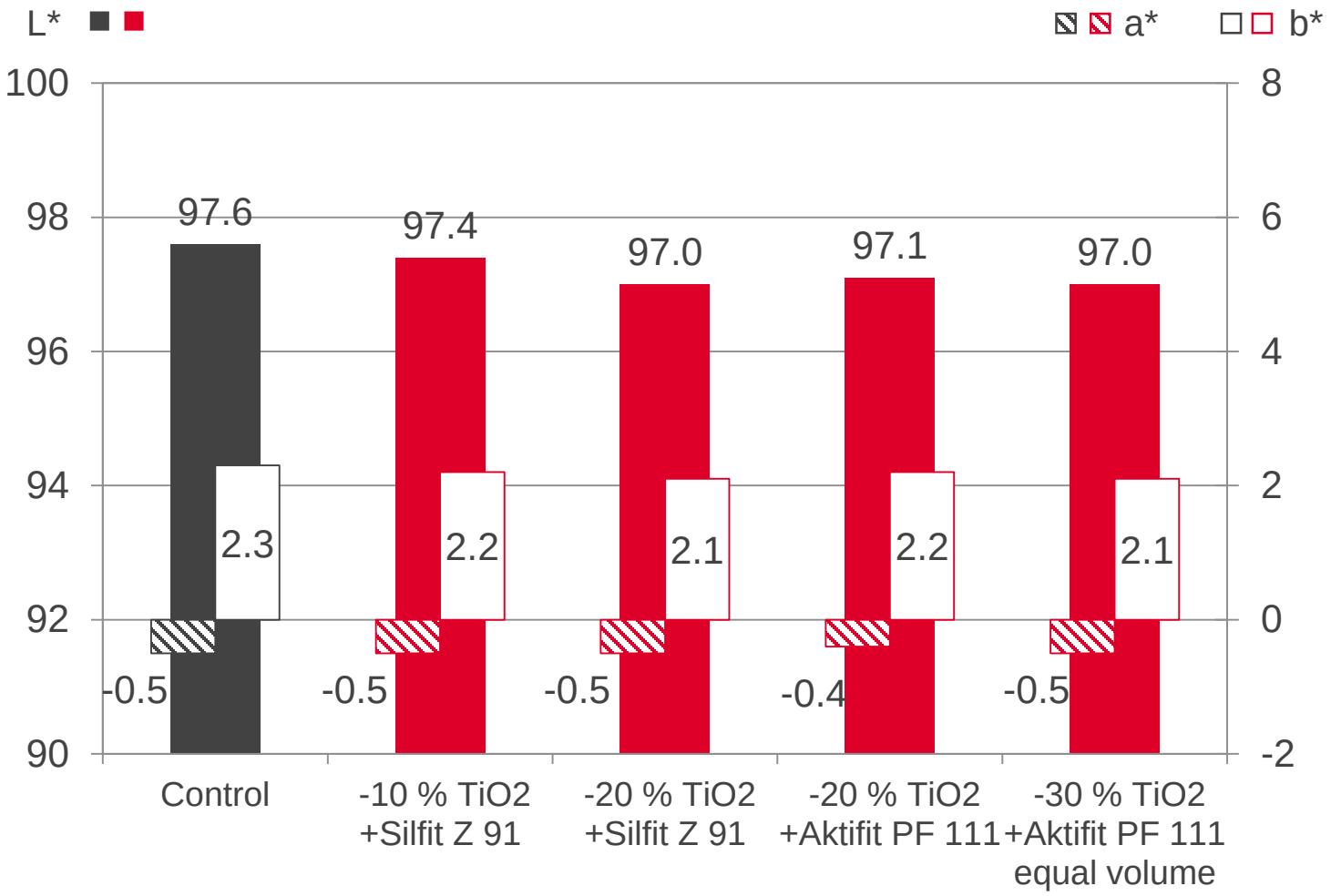
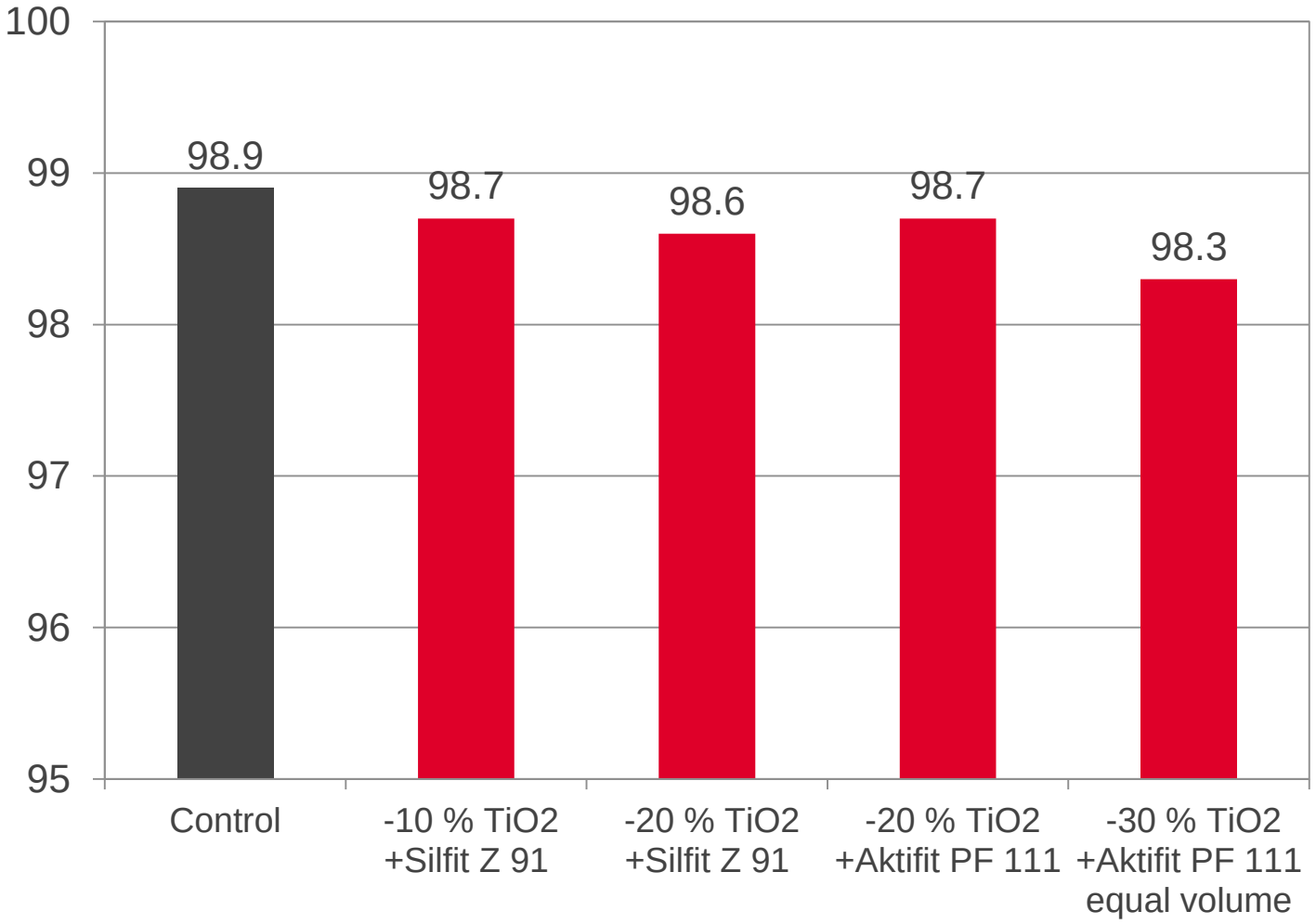
d/8°



Contrast Ratio

at 70 µm dry film thickness, [%]



Gloss 20°

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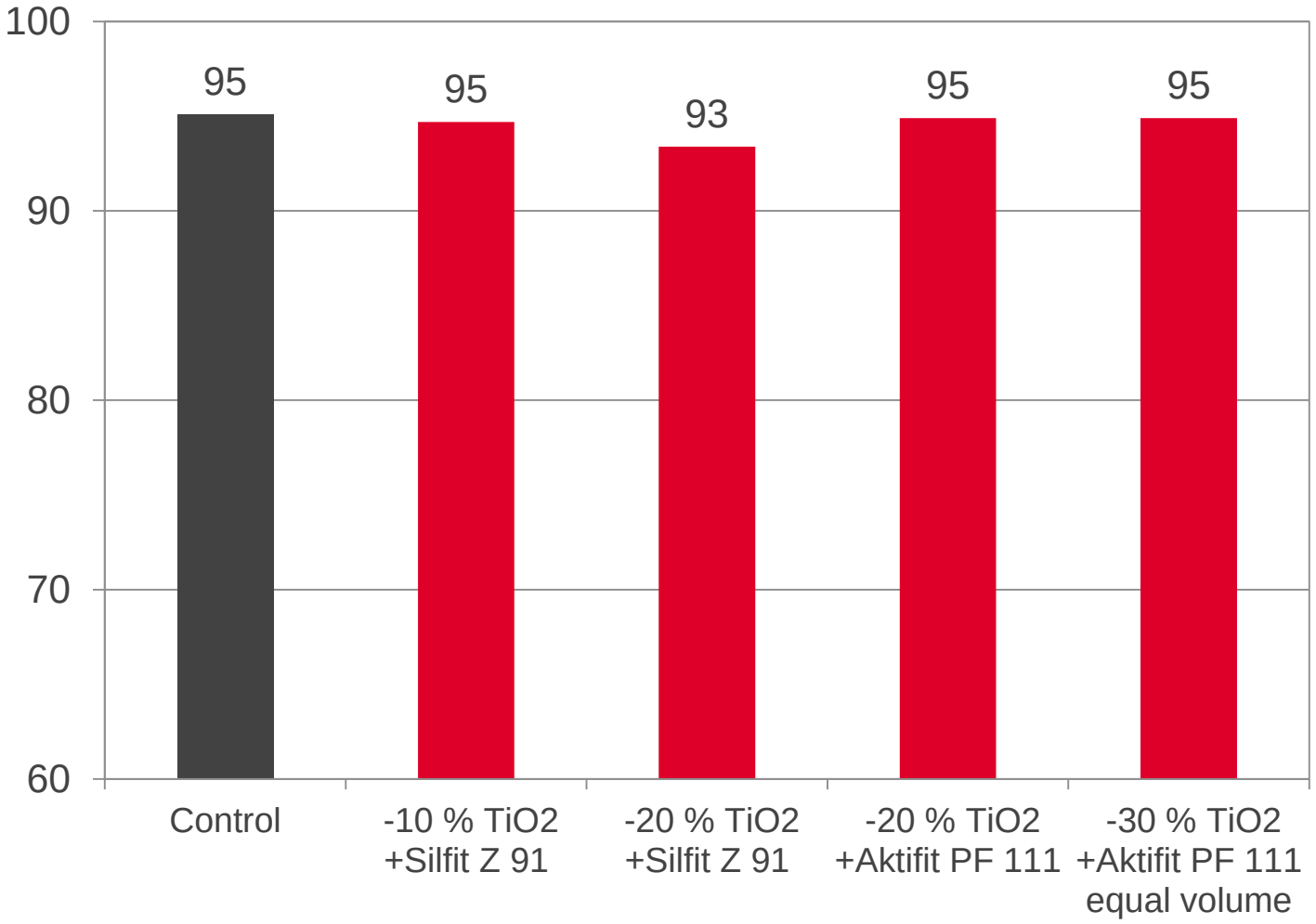
micro-TRI-gloss, [GU]



Haze

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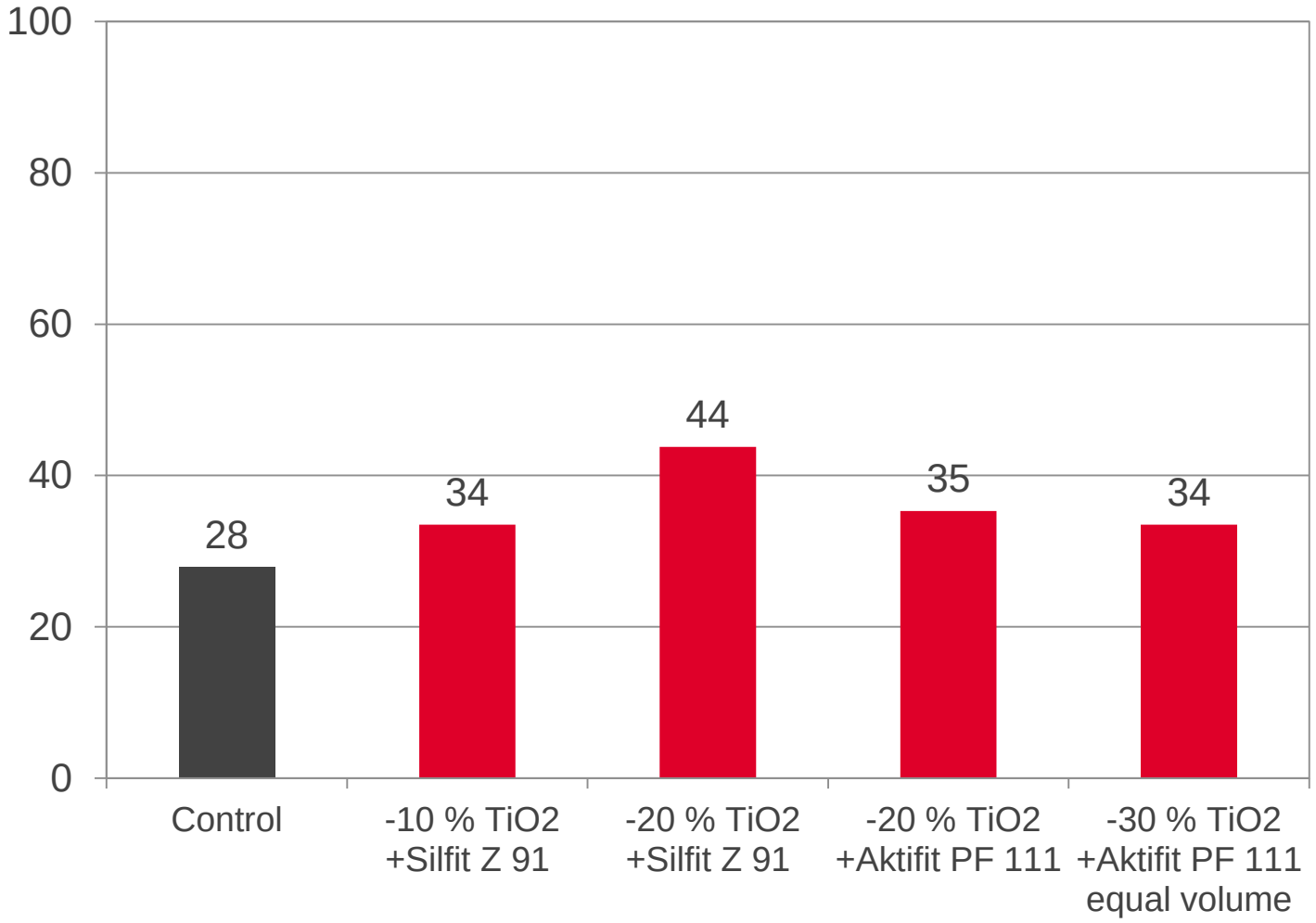
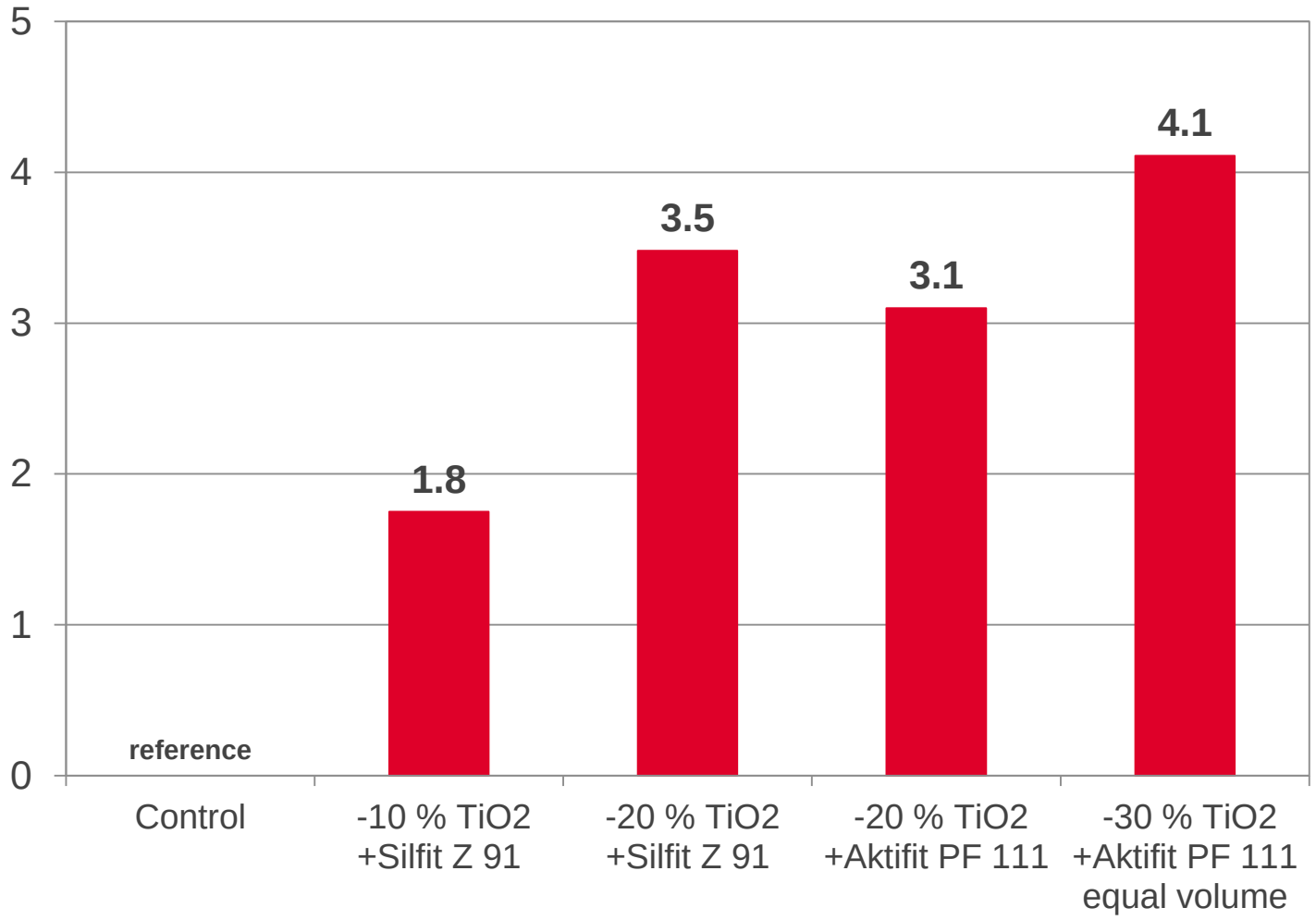
micro-haze



Cost Reduction Potential per Liter

[%] Germany 2020



Summary

The use of calcined Neuburg Siliceous Earth as a titanium dioxide substitute for decorative applications is shown in the example of 2 C PU top coat, the following advantages:

Silfit Z 91 and Aktifit PF 111

+ Very high brightness and color neutrality
+ High contrast ratio
+ Very high gloss
+ Very low haze
+ Cost reduction potential

In addition, when using Aktifit PF 111, the use of silica for rheology control can be dispensed with, thus avoiding its negative effect on gloss and haze as well as simplifying handling.

We supply material for good ideas!

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