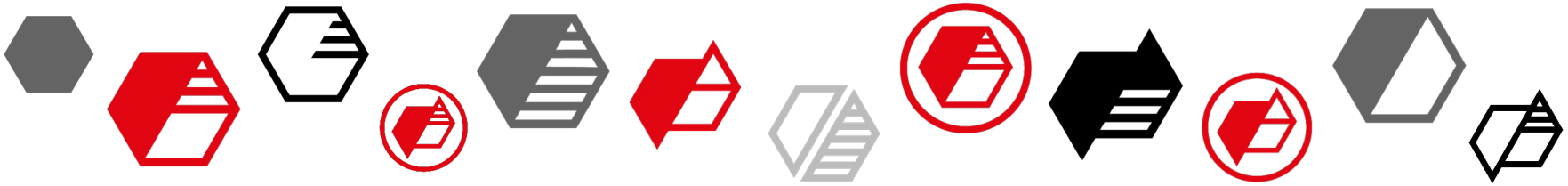


Calcined Neuburg Siliceous Earth in powder coatings (hybrid-based, white)

Reduced titanium dioxide content – What can Calcined Neuburg Siliceous Earth offer?

Author: Susanne Reiter

HOFFMANN MINERAL®
We supply material for good ideas

Contents

- Introduction
- Experimental
- Results
  - Color
  - Hiding power / opacity
  - Gloss and Haze
  - Leveling
  - Flexibility (impact test and cupping test)
  - Mechanical resistance (scratch test)
  - Density / spreading rate
  - Cost index
- Summary
- Appendix

Status Quo

An earlier study of a hybrid powder coating focused on replacing the common used filler barium sulfate with grades of Neuburg Siliceous Earth. Positive effects were found: optical and mechanical properties were maintained or even improved.

Studies in other coatings like Coil Coating Top Coat proved Calcined Neuburg Siliceous Earth´s potential for partially replacing titanium dioxide.

Titanium dioxide prices have risen considerably and continue to do so. Thus, the coating producers are looking for measures to compensate for these cost increases.

Objective

Thus the question comes up if Calcined Neuburg Siliceous Earth is capable of partially substituting titanium dioxide while maintaining mechanical and optical properties (particularly opacity).

The main filler remains in the formulation:

- natural barium sulfate

as example for low cost formulation with standard requirements

or

- precipitated barium sulfate grade

special grade for powder coatings with high quality optical properties

In addition, cost aspects were also taken into account.

Filler Characteristics

HOFFMANN MINERAL

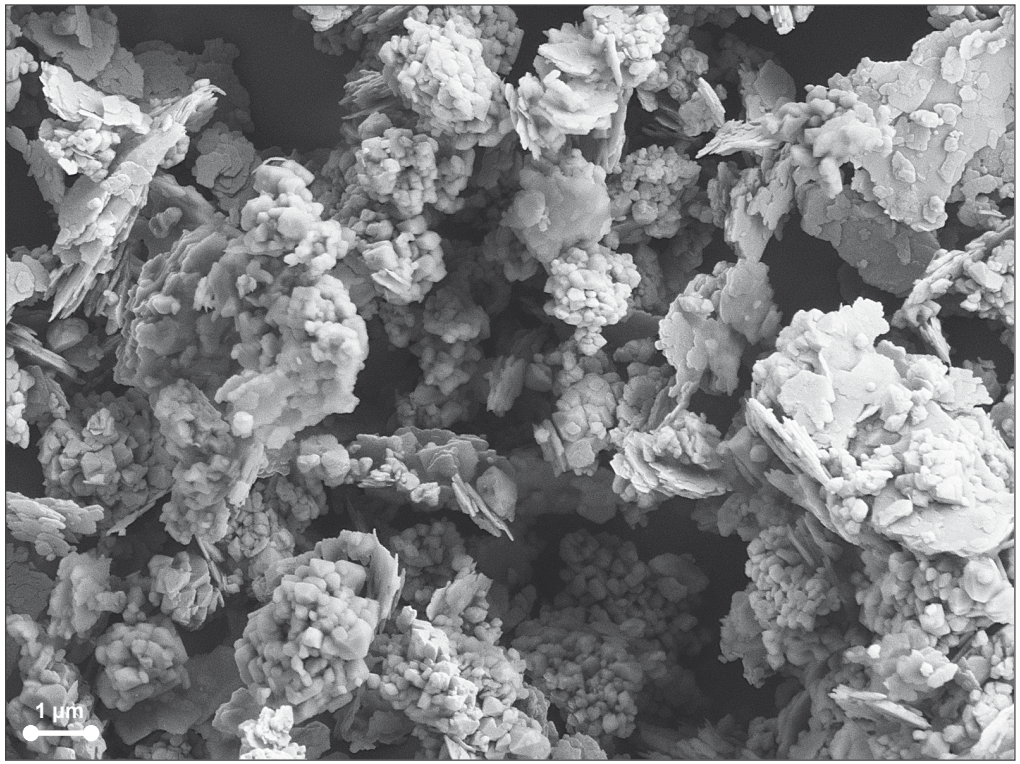
		Barium sulfate		Calcined Neuburg Siliceous Earth
		natural	ppt. special grade for powder coatings	Silfit Z 91
Morphology		corpuscular		corpuscular / lamellar aggregated
Density	[g/cm³]	4.4	4.4	2.6
Particle size d_{50}	[µm]	2.9	1.6	2.0
Particle size d_{97}	[µm]	14	5	10
Oil absorption	[g/100g]	14	22	60
Specific surface area BET	[m²/g]	0.8	2.6	7.5

Filler Characteristics

Color	Barium sulfate		Calcined Neuburg Siliceous Earth
	natural	ppt. special grade for powder coatings	Silfit Z 91
L*	95	97	95
a*	- 0.3	- 0.5	- 0.2
b*	0.2	0.5	1.2

What is Neuburg Siliceous Earth?

HOFFMANN MINERAL



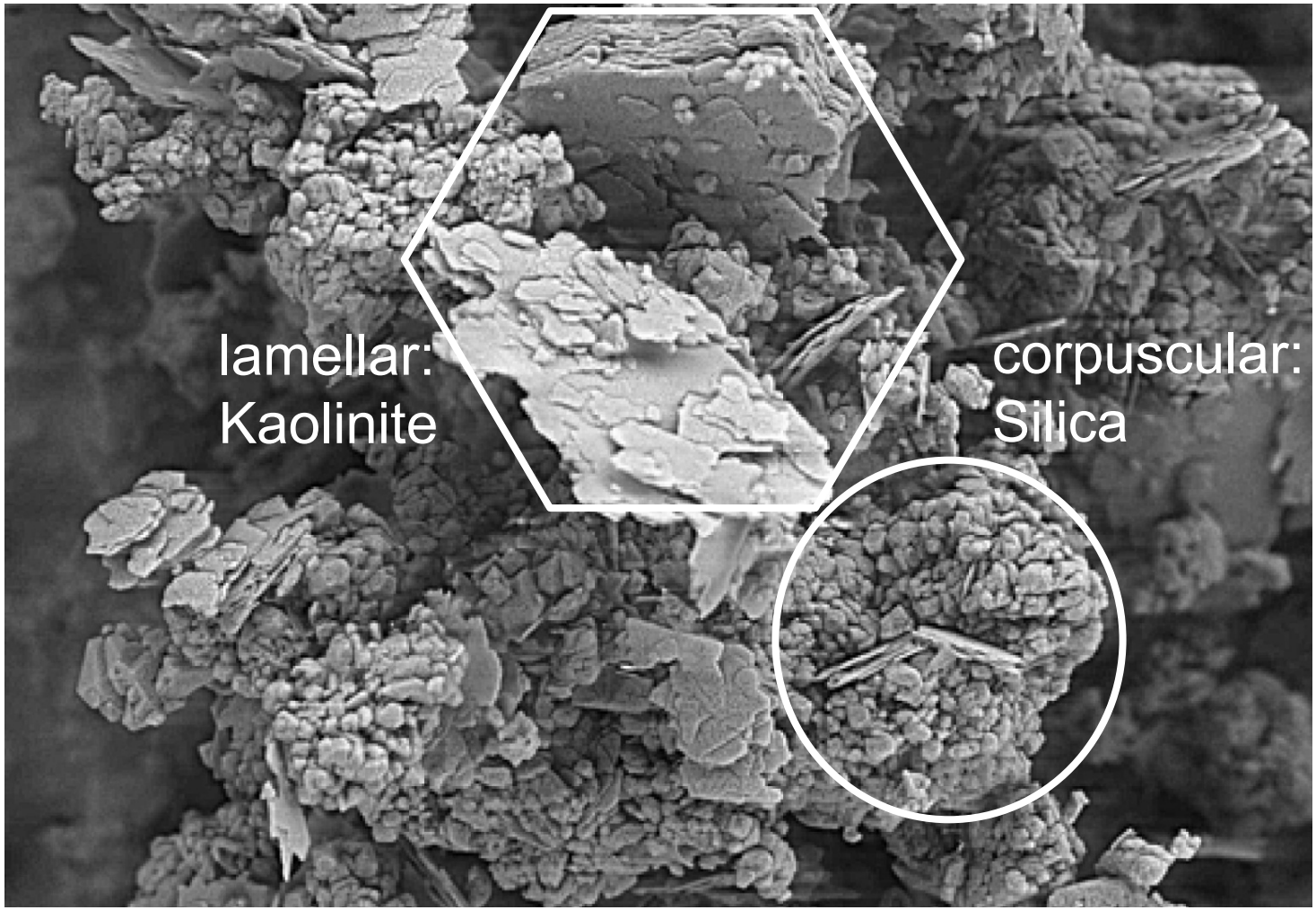
A natural combination of corpuscular Neuburg silica and lamellar kaolinite: a loose mixture impossible to separate by physical methods.

The silica portion exhibits a round grain shape and consists of aggregated primary particles of about 200 nm diameter.

Morphology of Neuburg Siliceous Earth

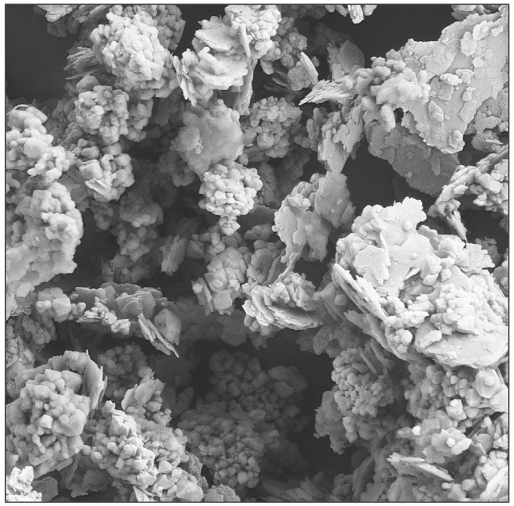
HOFFMANN MINERAL

Magnification 10.000x



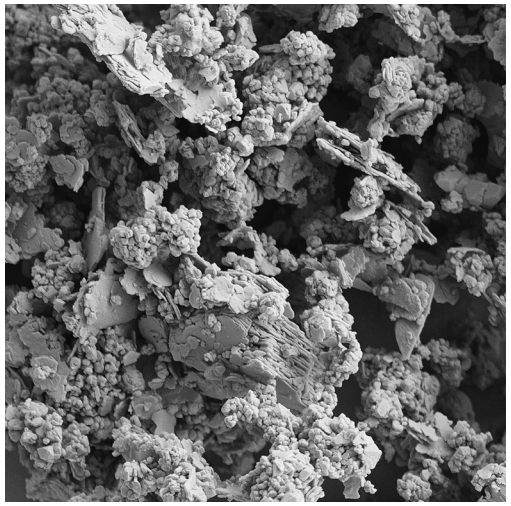
Calcined Neuburg Siliceous Earth

A downstream thermal process leads 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.

Base Formulation

INTRODUCTION

EXPERIMENTAL

RESULTS

SUMMARY

Parts per weight = %

	Base formulation
Crylcoat 1771-3	39.0
Epikote 1003	18.0
Additol P 896	3.0
Titanium dioxide	19.5
Barium sulfate	20.0
Benzoin	0.5
Total	100.0

PVC [%]	16.3

Preparation

Premix	Mixaco Mixer LAB CM 3, 2 min, 1000 rpm
Extruder	Coperion ZSK 18, twin screw, shaft speed 350 rpm, heating zone 50°C/100°C/100°C/100°C/100°C
Micronizing	Retsch ZM 100, 0.5 sieve, 18000 rpm
Sieving	Fritsch Analysette 3 PRO, 5-8 min, mesh size 100 µm; Amplitude 2.5 mm
Application	Powder gun GEMA Corona, Type PG 1-B, 80 kV, 2 bar, dry film thickness ~ 70 µm
Substrate	Q-Panels: Aluminum A 36 and A 48
Curing	15 min at 180 °C oven temperature, corresponds to approx. 10 min PMT 180 °C

What kind of barium sulfate do you use?

- Barium sulfate natural 

or

- Barium sulfate precipitated 

Formulations

HOFFMANN MINERAL

Parts per weight

	Control $BaSO_4$	- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91
Crylcoat 1771-3	39.0	39.0	39.0	39.0
Epikote 1003	18.0	18.0	18.0	18.0
Additol P 896	3.0	3.2	3.2	3.2
Titanium dioxide	19.5	15.6	15.6	15.6
$BaSO_4$ natural	20.0	20.0	13.4	-
Silfit Z 91	-	3.9	7.8	15.7
Benzoin	0.5	0.5	0.5	0.5
Total	**100.0**	**100.2**	**97.5**	**92.0**
PVC [%]	16.3	17.1	17.1	17.1

Formulations

HOFFMANN MINERAL

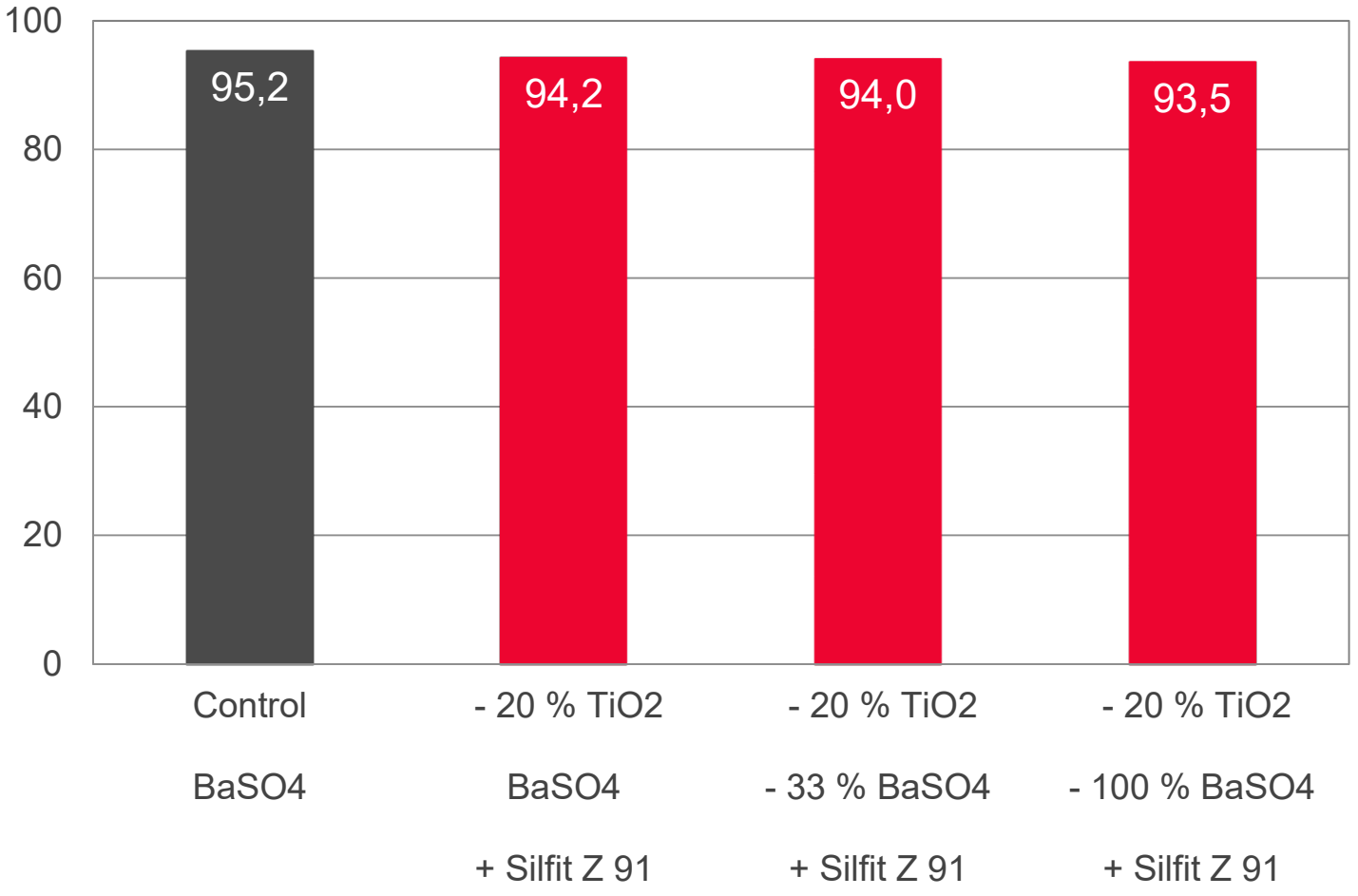
Parts per cent (%)

	Control $BaSO_4$	- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91
Crylcoat 1771-3	39.0	38.9	40.0	42.4
Epikote 1003	18.0	18.0	18.5	19.6
Additol P 896	3.0	3.2	3.3	3.5
Titanium dioxide	19.5	15.6	16.0	16.9
$BaSO_4$ natural	20.0	20.0	13.7	-
Silfit Z 91	-	3.9	8.0	17.1
Benzoin	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**
PVC [%]	16.3	17.1	17.1	17.1

Color
Brightness L*

HOFFMANN MINERAL

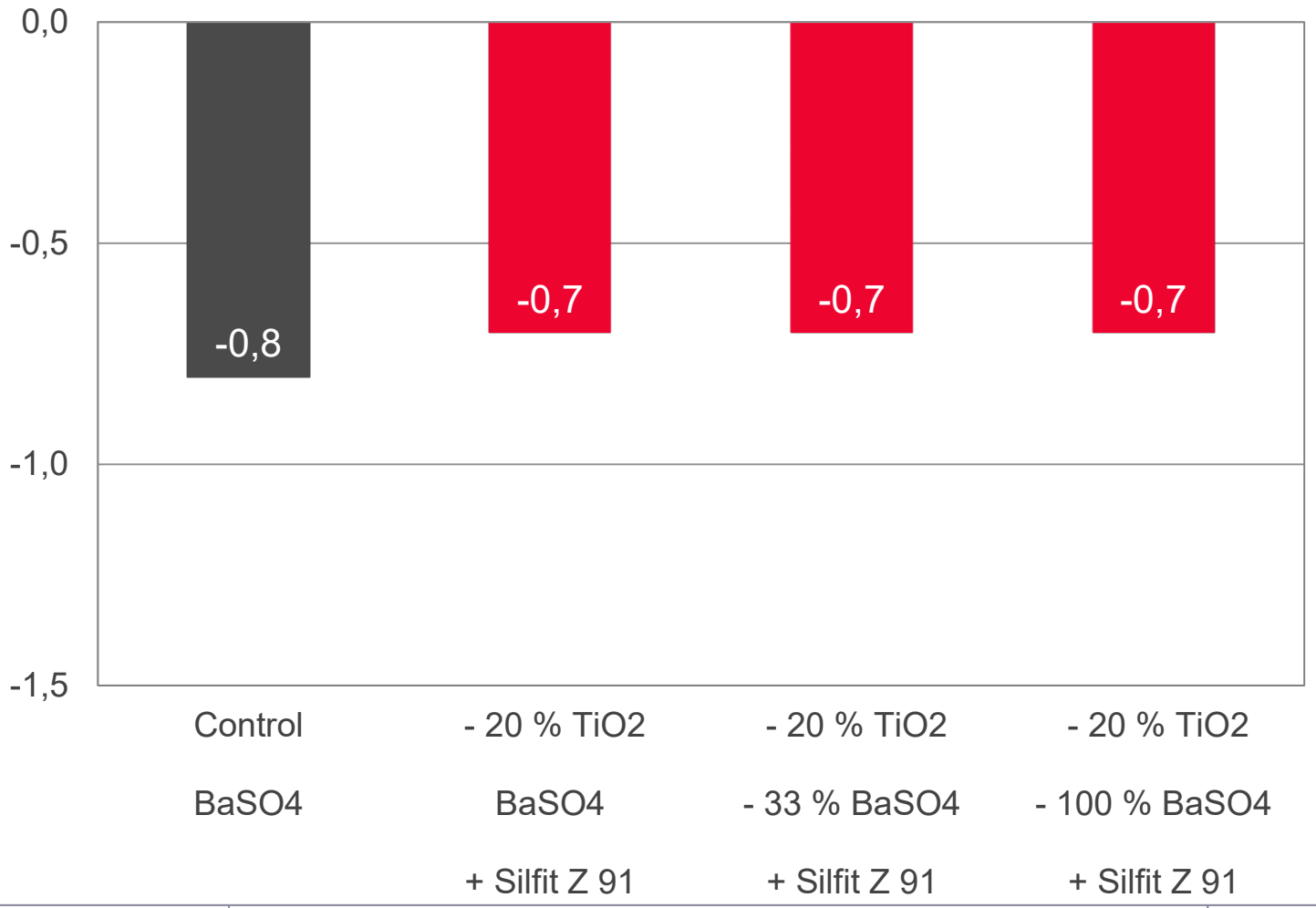
CIE L*



Color

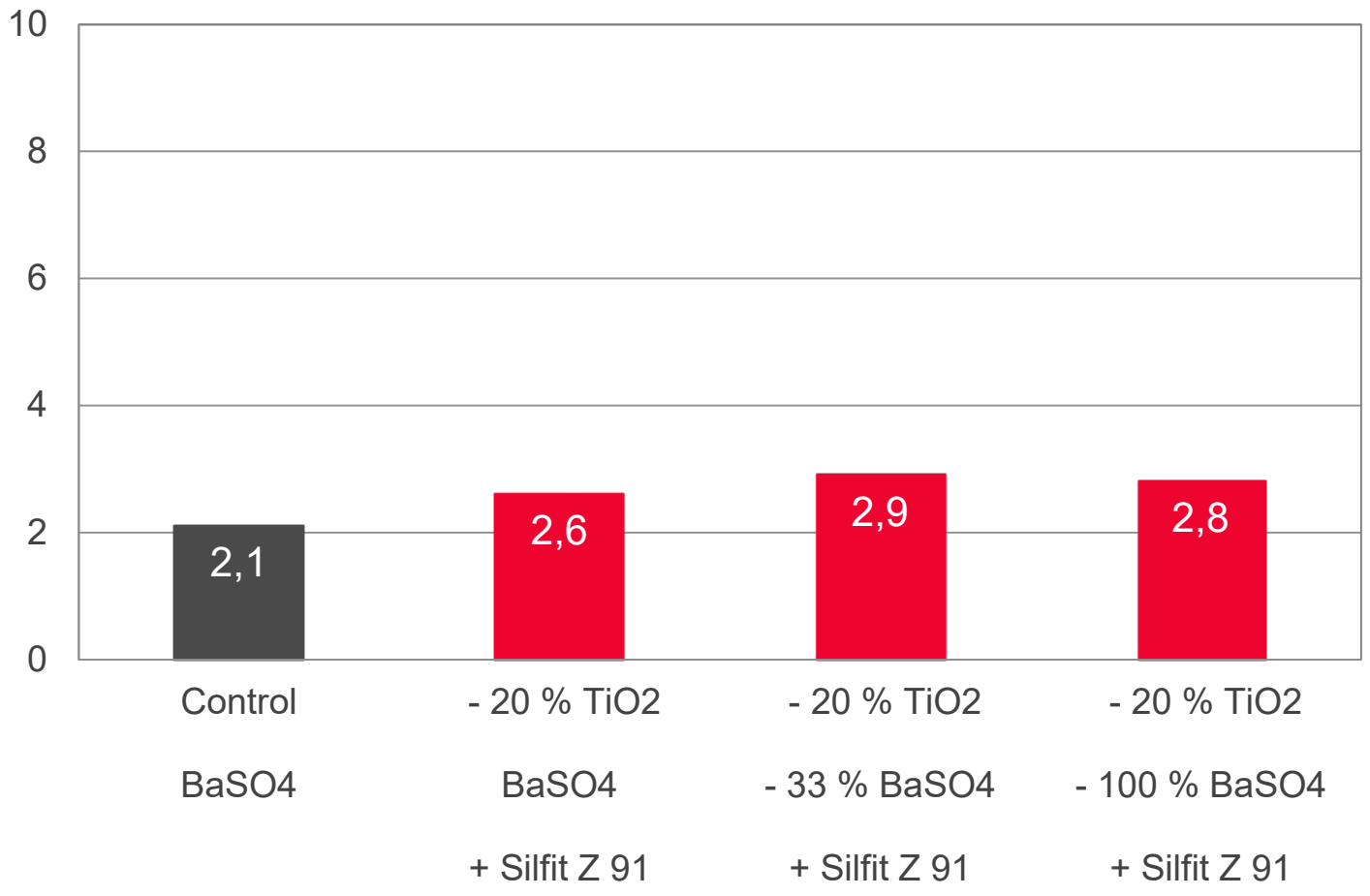
Red/green-ratio a*

CIE a*



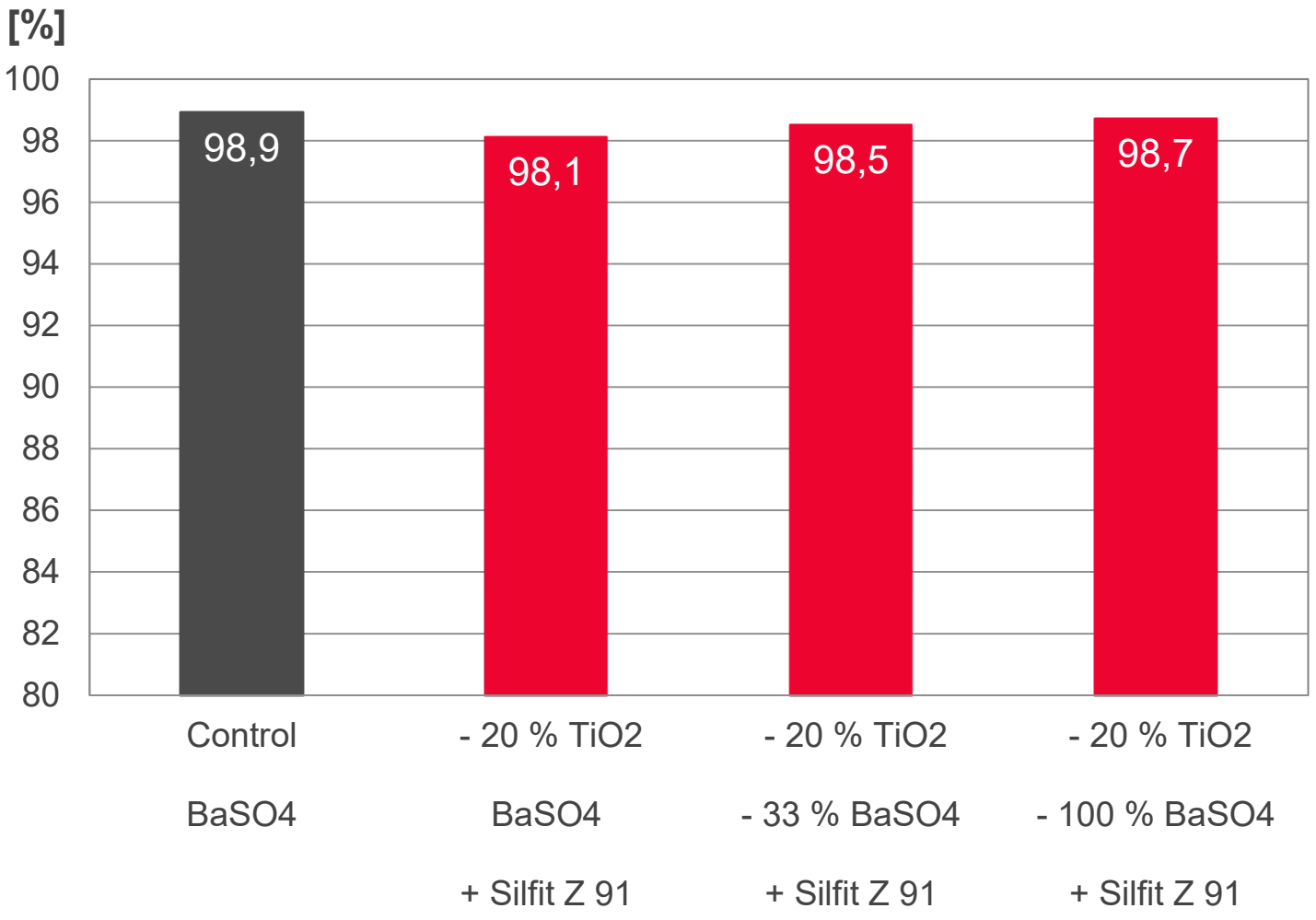
Color
Yellow/blue-ratio b*

CIE b*

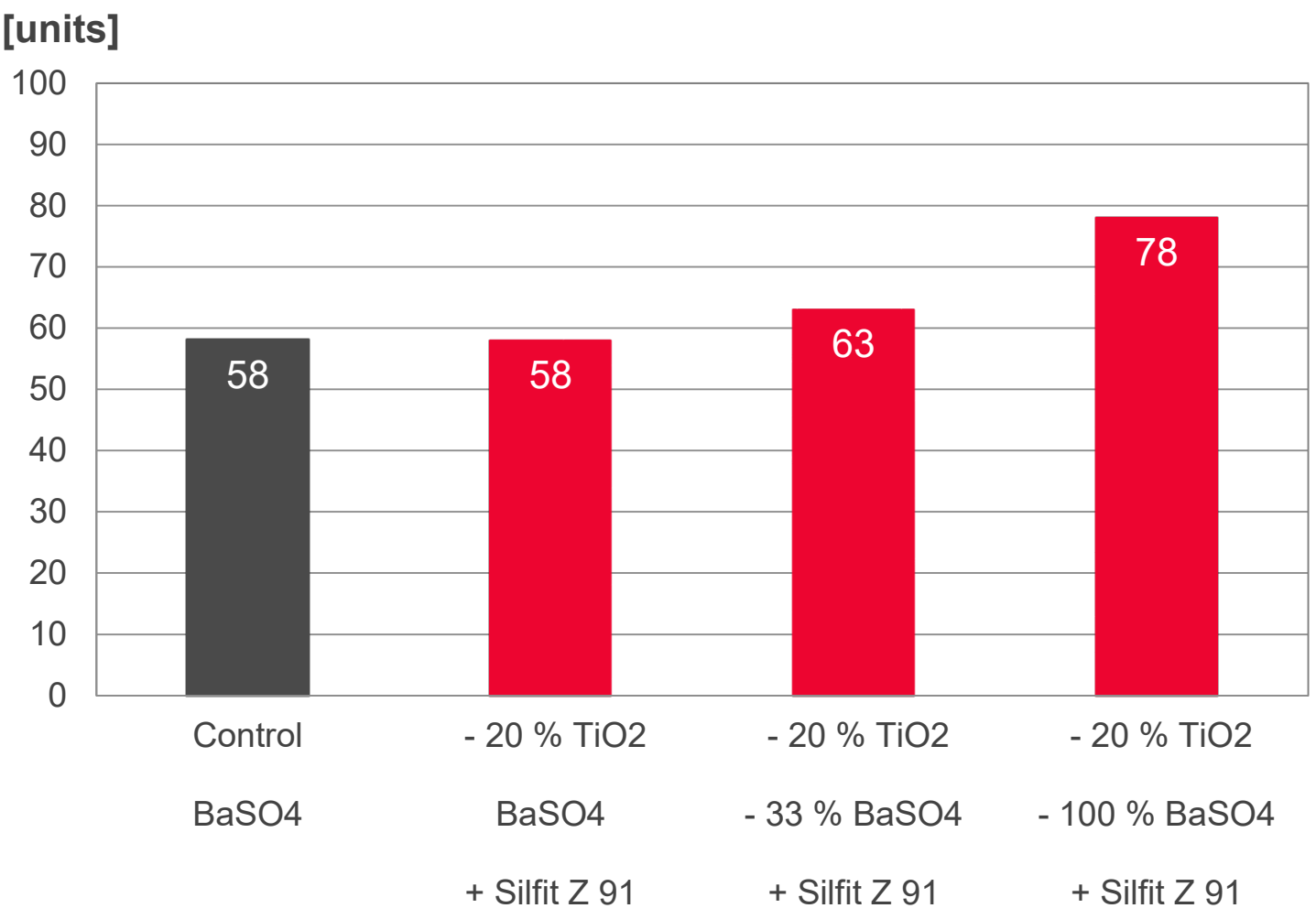


Hiding Power / Opacity

Contrast ratio at a dry film thickness ~ 70 µm



Gloss 20°



Haze

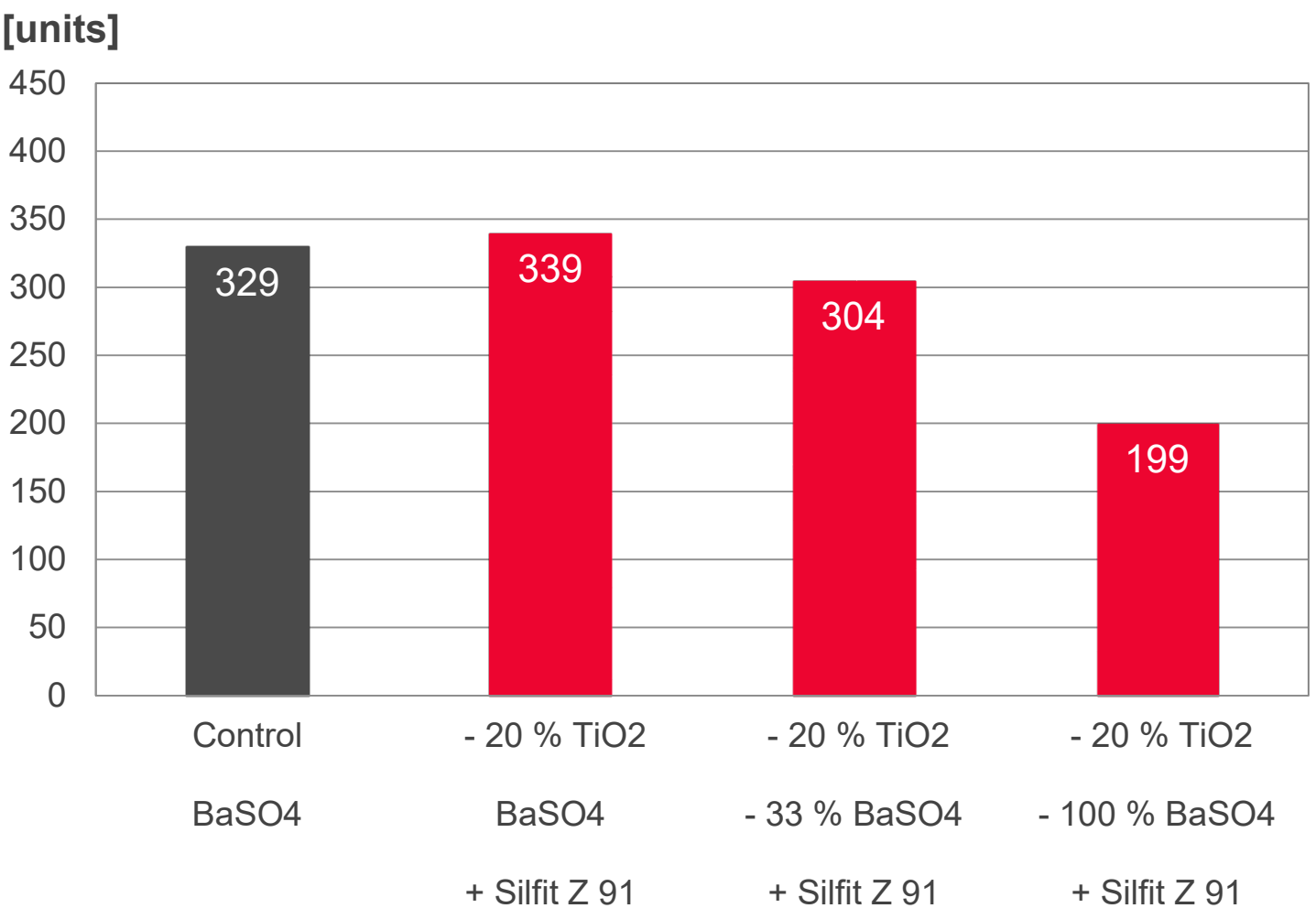
INTRODUCTION

EXPERIMENTAL

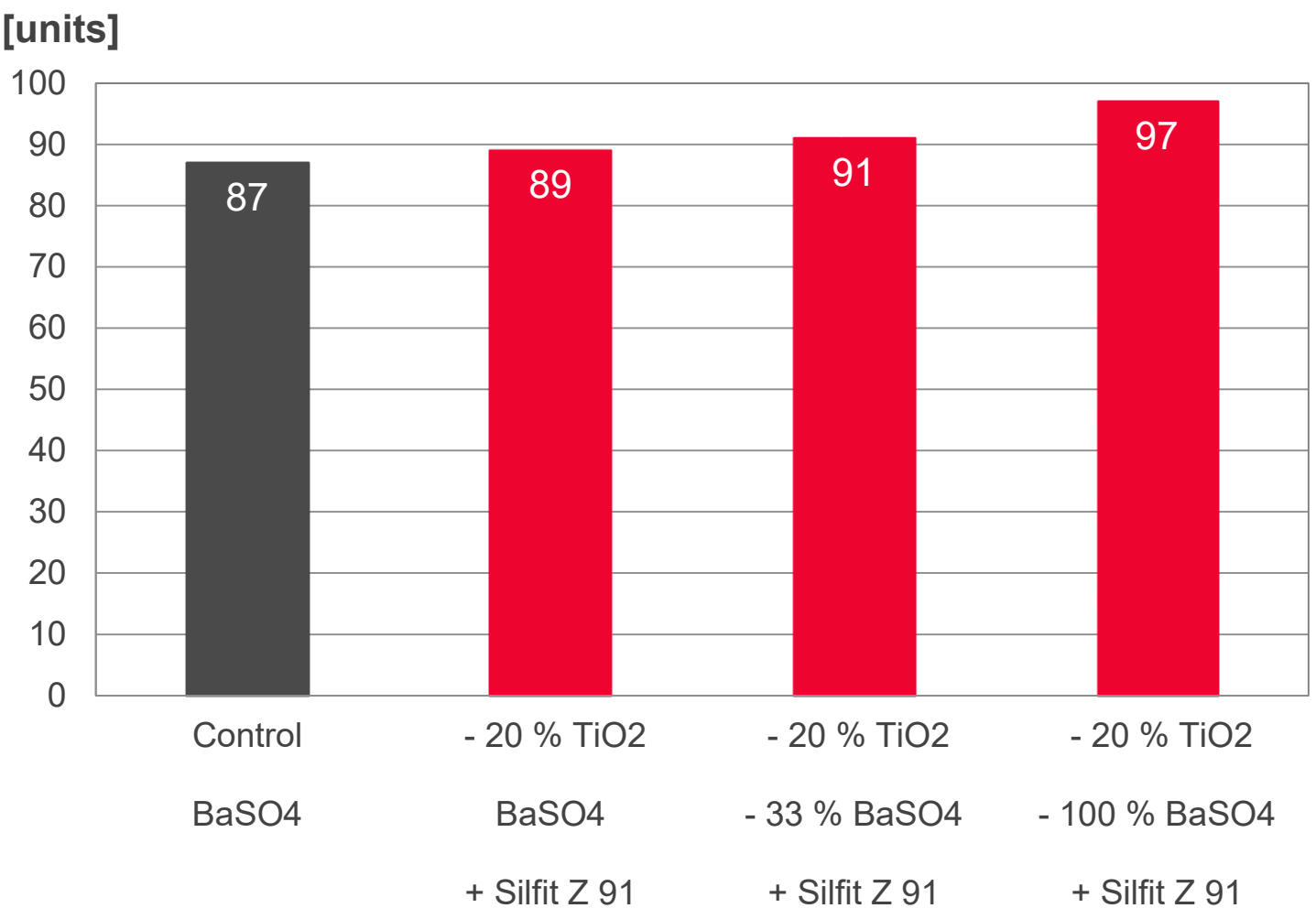
RESULTS

- $BaSO_4$ natural

SUMMARY

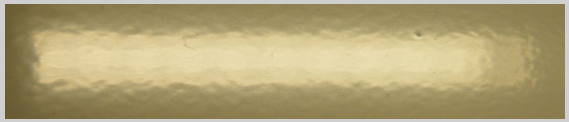
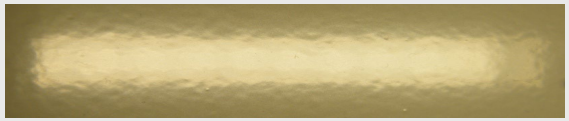


Gloss 60°



Leveling

Appearance of surface (visual assessment)
Substrate: aluminum A 48

	Reflection of overhead light	
Control $BaSO_4$		0
- 20 % TiO_2 $BaSO_4$ + Silfit Z 91		0
- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91		0+
- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91		+

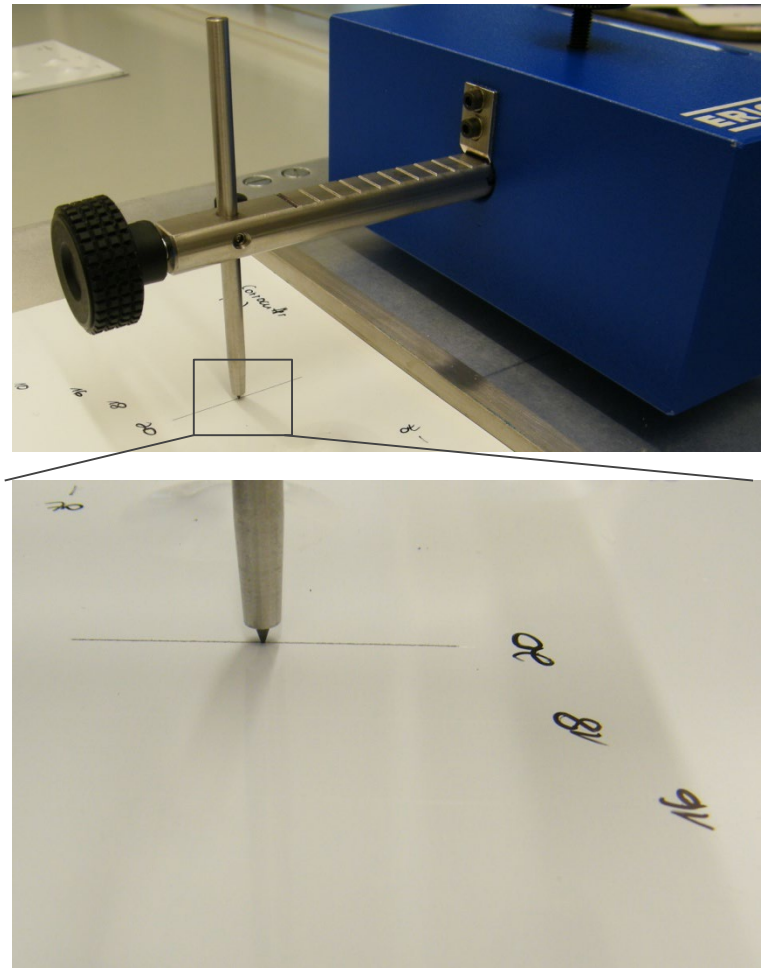
Flexibility

Impact Test ASTM D 2794 (weight: 2 lbs); no visible cracks
Cupping Test DIN ISO 1520
Substrate: aluminum A 36

	Reverse Impact Test [inch pounds]	Cupping Test [mm]
Control $BaSO_4$	18	6.9
- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	14	6.4
- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	12	6.7
- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91	28	6.4

Mechanical Resistance

Mechanical resistance is tested by scratching the coating down to the substrate with a hard metal tip (substrate: aluminum A 48)



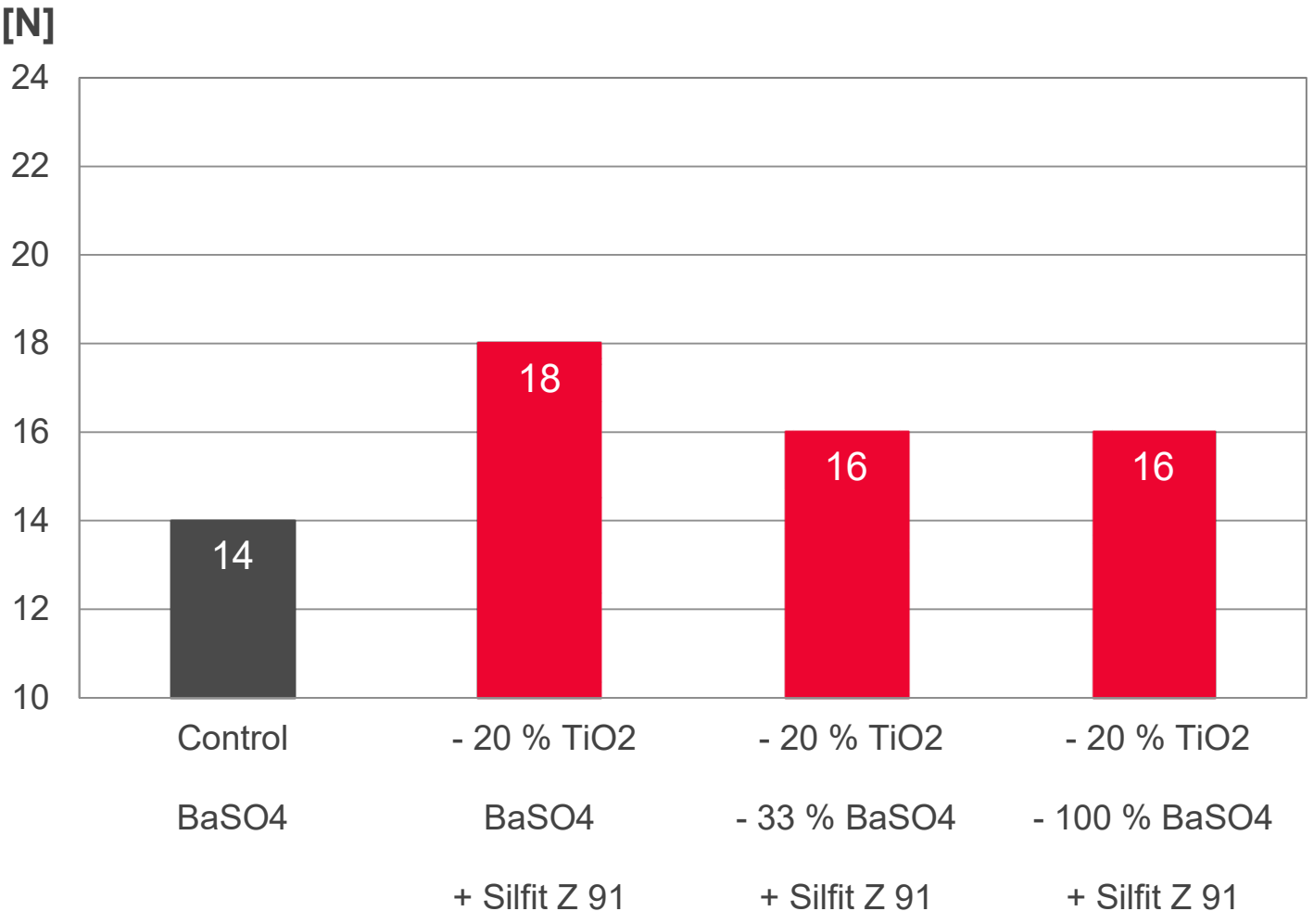
Testing equipment (Erichsen Corrocutter, model 639) with loaded weight, force from 2 – 20 Newton

Round hard metal tip (van Laar, diameter 0.5 mm)

Mechanical Resistance

HOFFMANN MINERAL

Scratch test with Corrocutter



Density

calculated

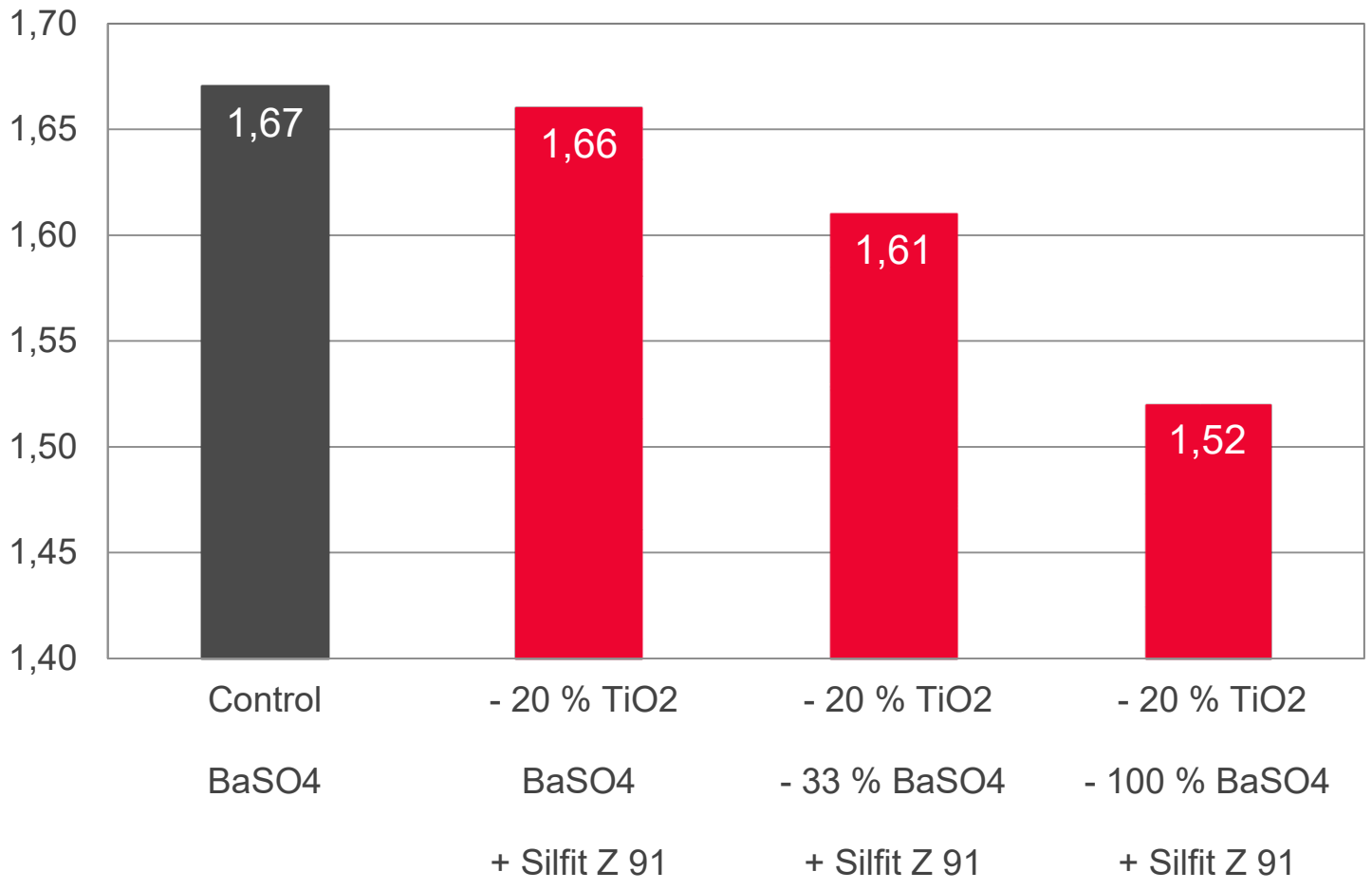
INTRODUCTION

EXPERIMENTAL

RESULTS

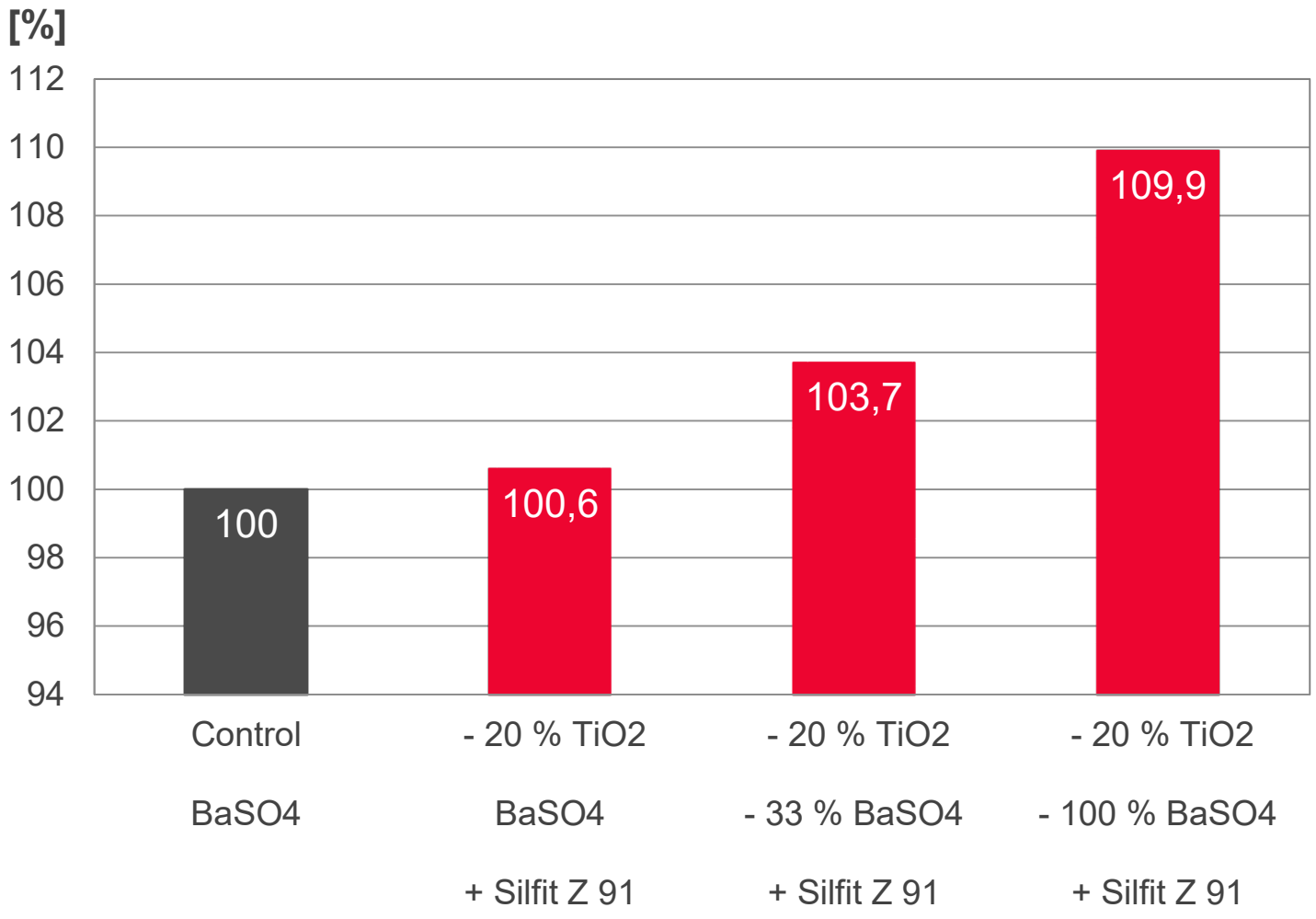
- $BaSO_4$ natural

SUMMARY



Spreading Rate

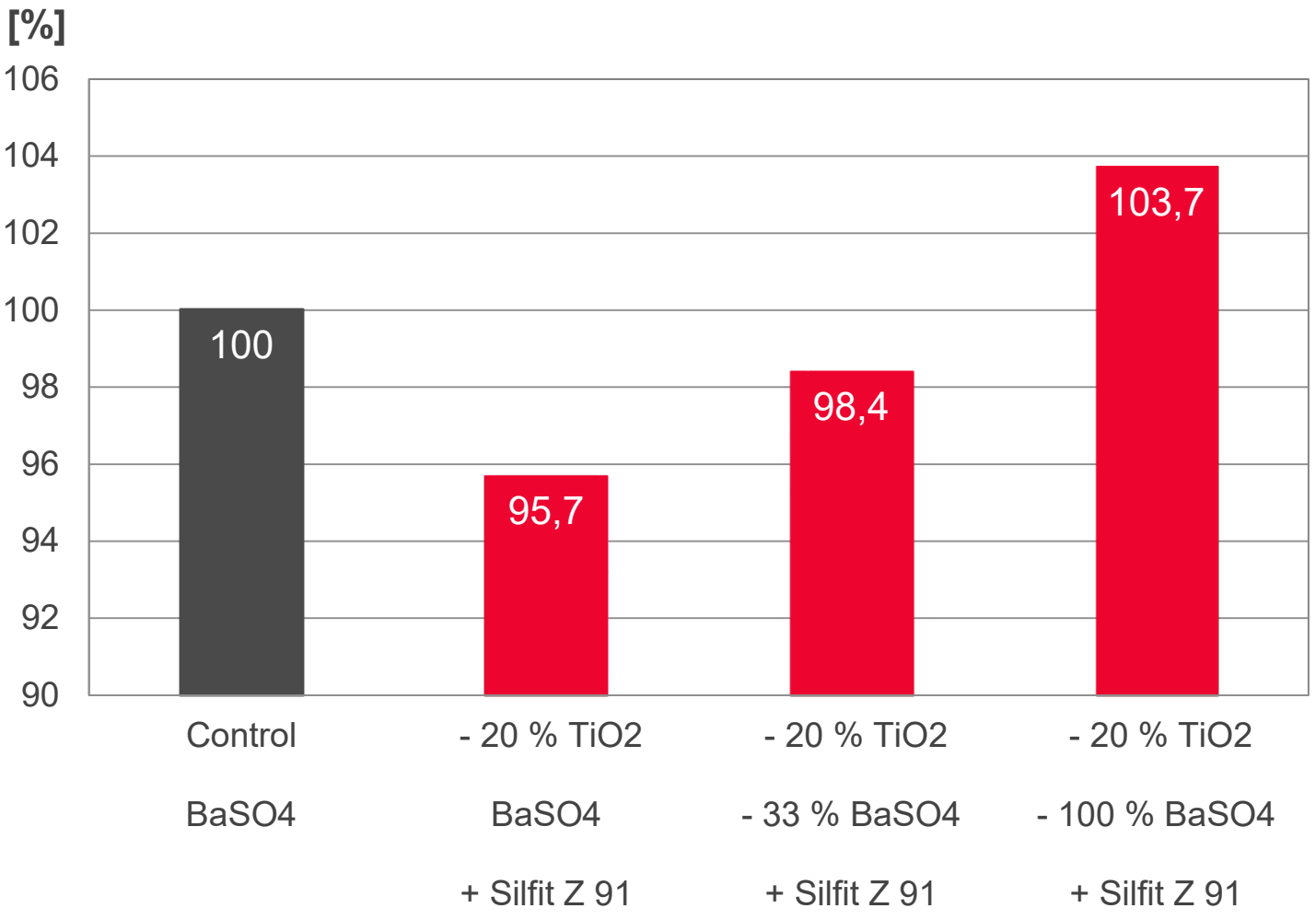
Area coatable per mass unit (e.g. m²/kg powder coating material)



Cost Index
Based on Weight

HOFFMANN MINERAL

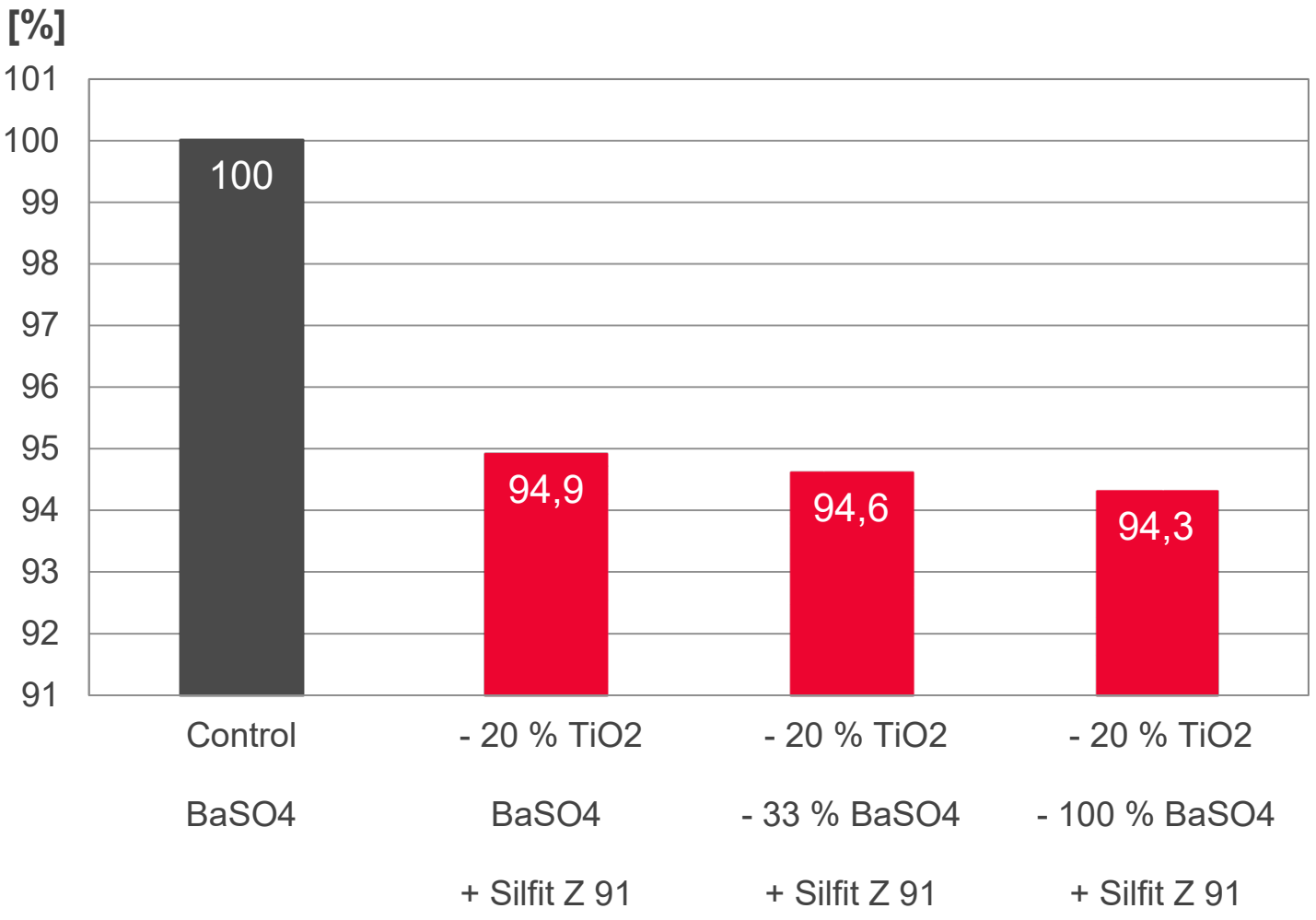
Control = 100 % (Base: Germany 2011)



Cost Index
Based on Volume

HOFFMANN MINERAL

Control = 100 % (Base: Germany 2011)



Summary

Replacement of 20 % titanium dioxide at equal weight with Silfit Z 91 gave rise to the following effects:

- similar optical properties and flexibility

+ improved scratch resistance

+ cost reduction potential

Additional substitution of the natural barium sulfate by Silfit Z 91 improved furthermore:

+ higher gloss

+ lower haze

+ better leveling

+ higher spreading rate (lower density of powder coating)

+ cost reduction potential

We supply material for good ideas!

HOFFMANN MINERAL GmbH
Muenchener Straße 75
DE-86633 Neuburg (Donau)

Phone: +49 8431 53-0
Internet: www.hoffmann-mineral.de
E-mail: info@hoffmann-mineral.com

Formulations

HOFFMANN MINERAL

Parts per weight

	Control $BaSO_4$	- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91
Crylcoat 1771-3	39.0	39.0	39.0	39.0
Epikote 1003	18.0	18.0	18.0	18.0
Additol P 896	3.0	3.2	3.2	3.2
Titanium dioxide	19.5	15.6	15.6	15.6
$BaSO_4$ ppt	20.0	20.0	13.4	-
Silfit Z 91	-	3.9	7.8	15.7
Benzoin	0.5	0.5	0.5	0.5
Total	**100.0**	**100.2**	**97.5**	**92.0**
PVC [%]	16.3	17.1	17.1	17.1

Formulations

HOFFMANN MINERAL

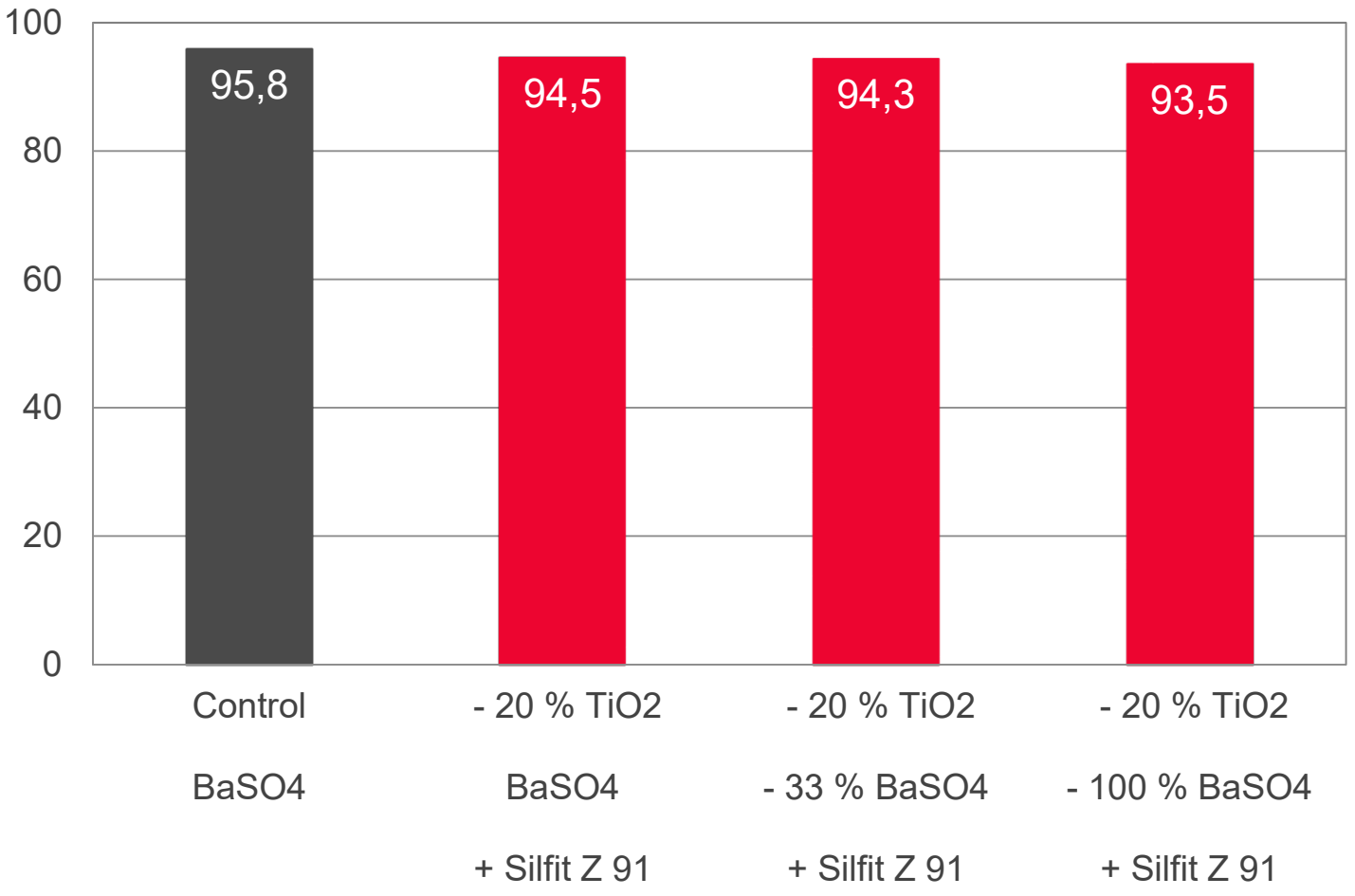
Parts per cent (%)

	Control $BaSO_4$	- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91
Crylcoat 1771-3	39.0	38.9	40.0	42.4
Epikote 1003	18.0	18.0	18.5	19.6
Additol P 896	3.0	3.2	3.3	3.5
Titanium dioxide	19.5	15.6	16.0	16.9
$BaSO_4$ ppt	20.0	20.0	13.7	-
Silfit Z 91	-	3.9	8.0	17.1
Benzoin	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**
PVC [%]	16.3	17.1	17.1	17.1

Color
Brightness L*

HOFFMANN MINERAL

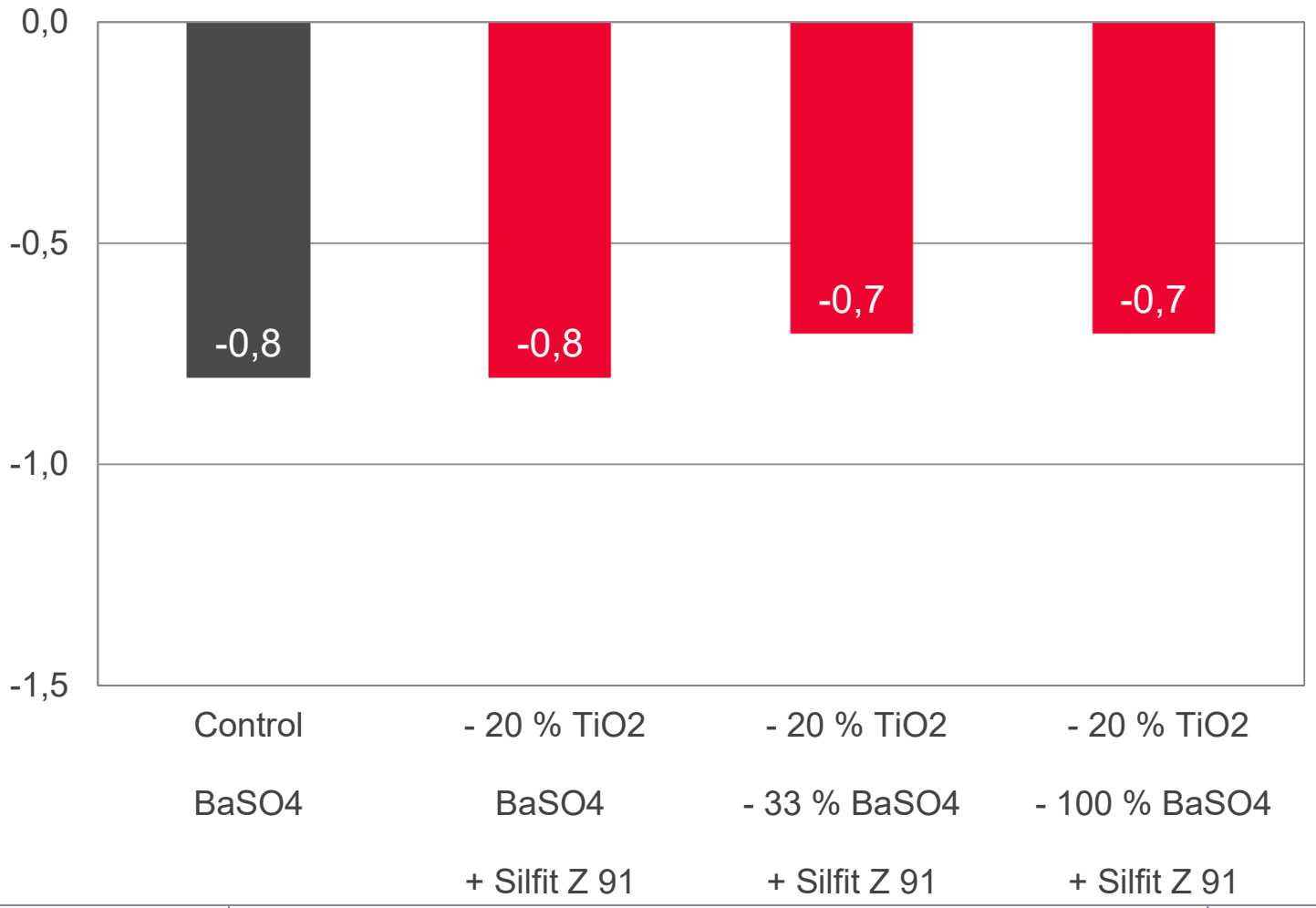
CIE L*



Color
Red/green-ratio a*

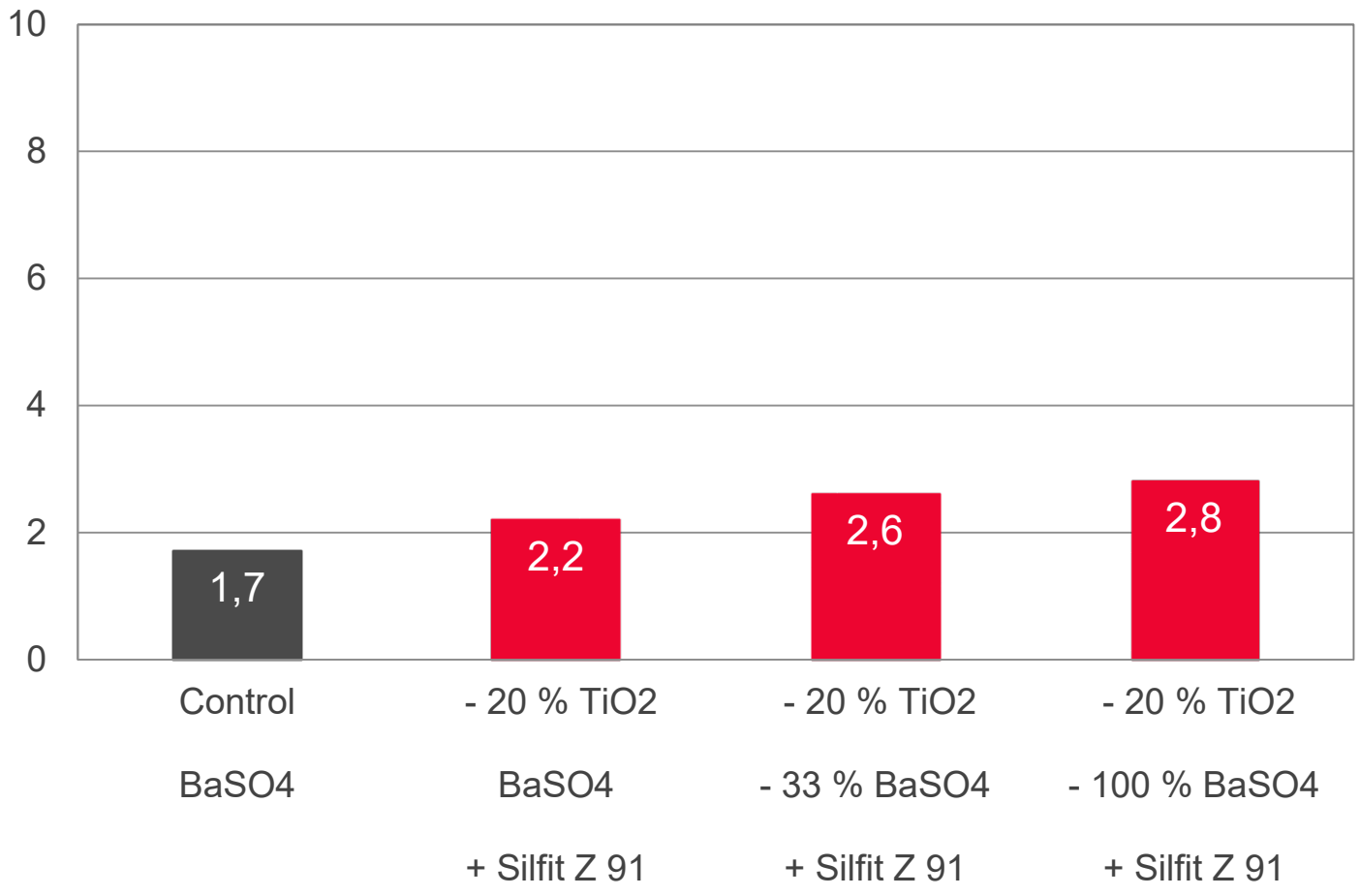
HOFFMANN MINERAL

CIE a*



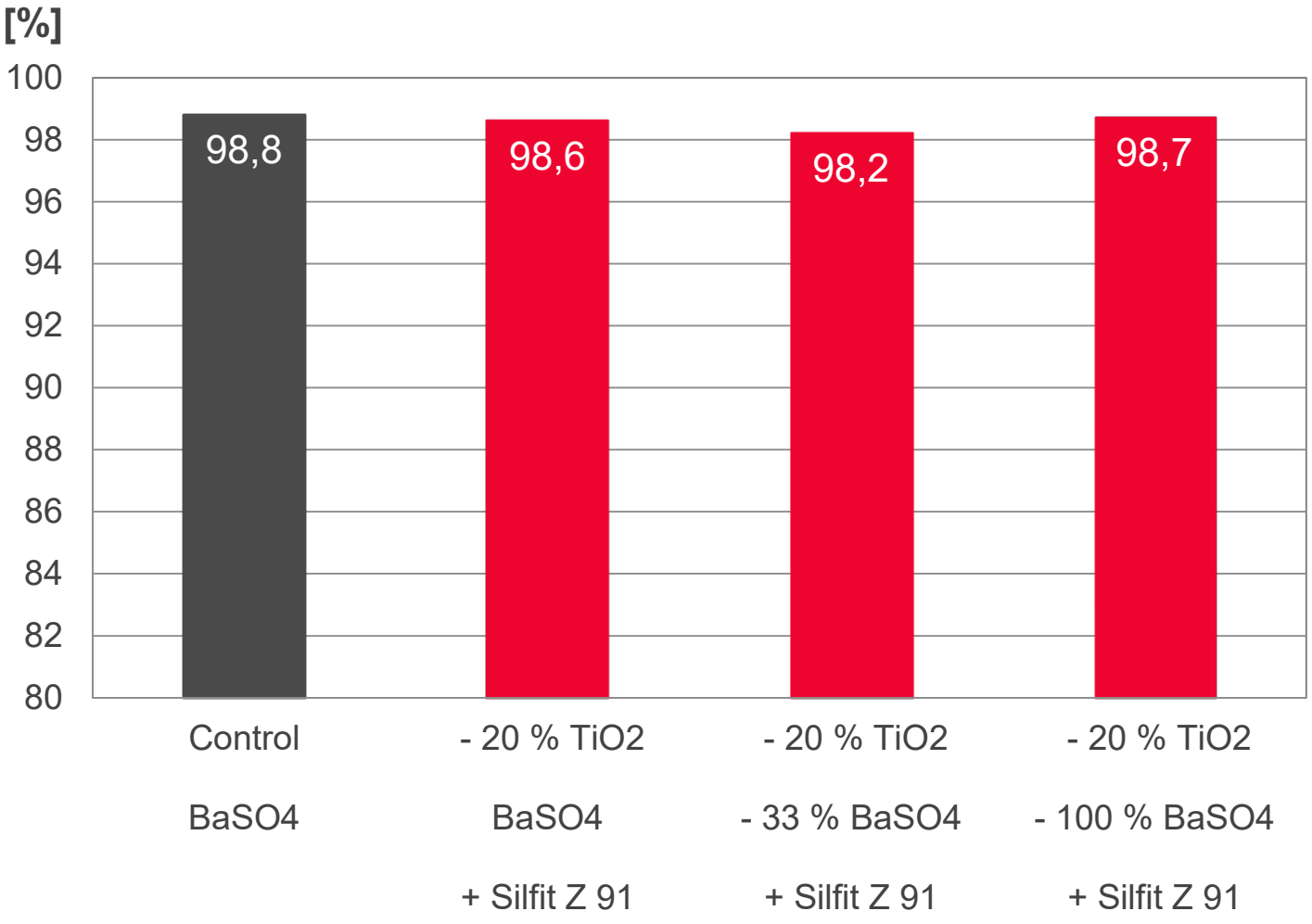
Color
Yellow/blue-ratio b*

CIE b*



Hiding Power / Opacity

Contrast ratio at a dry film thickness ~ 70 µm



Gloss 20°

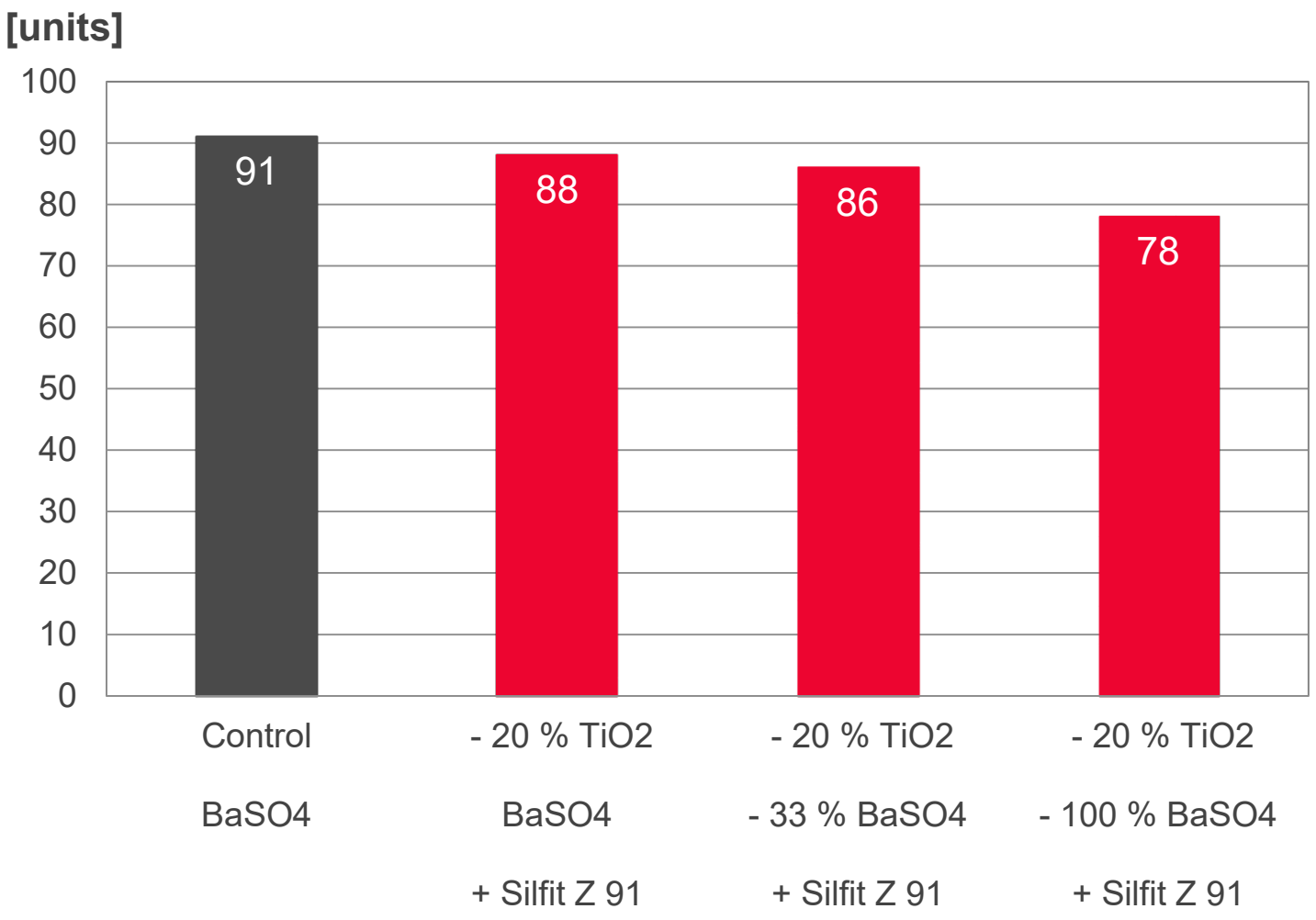
INTRODUCTION

EXPERIMENTAL

RESULTS

- $BaSO_4$ ppt

SUMMARY



Haze

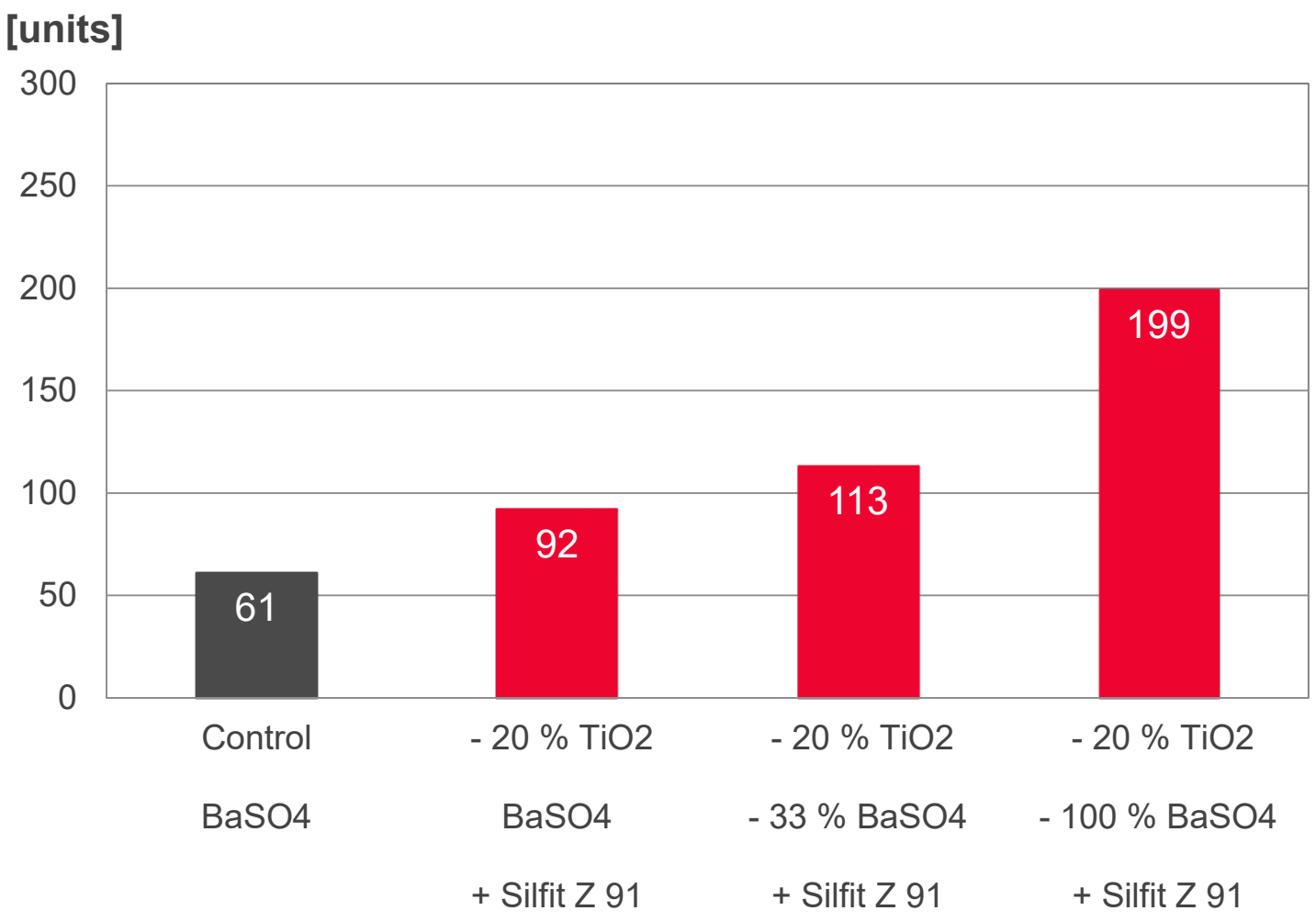
INTRODUCTION

EXPERIMENTAL

RESULTS

- $BaSO_4$ ppt

SUMMARY



Gloss 60°

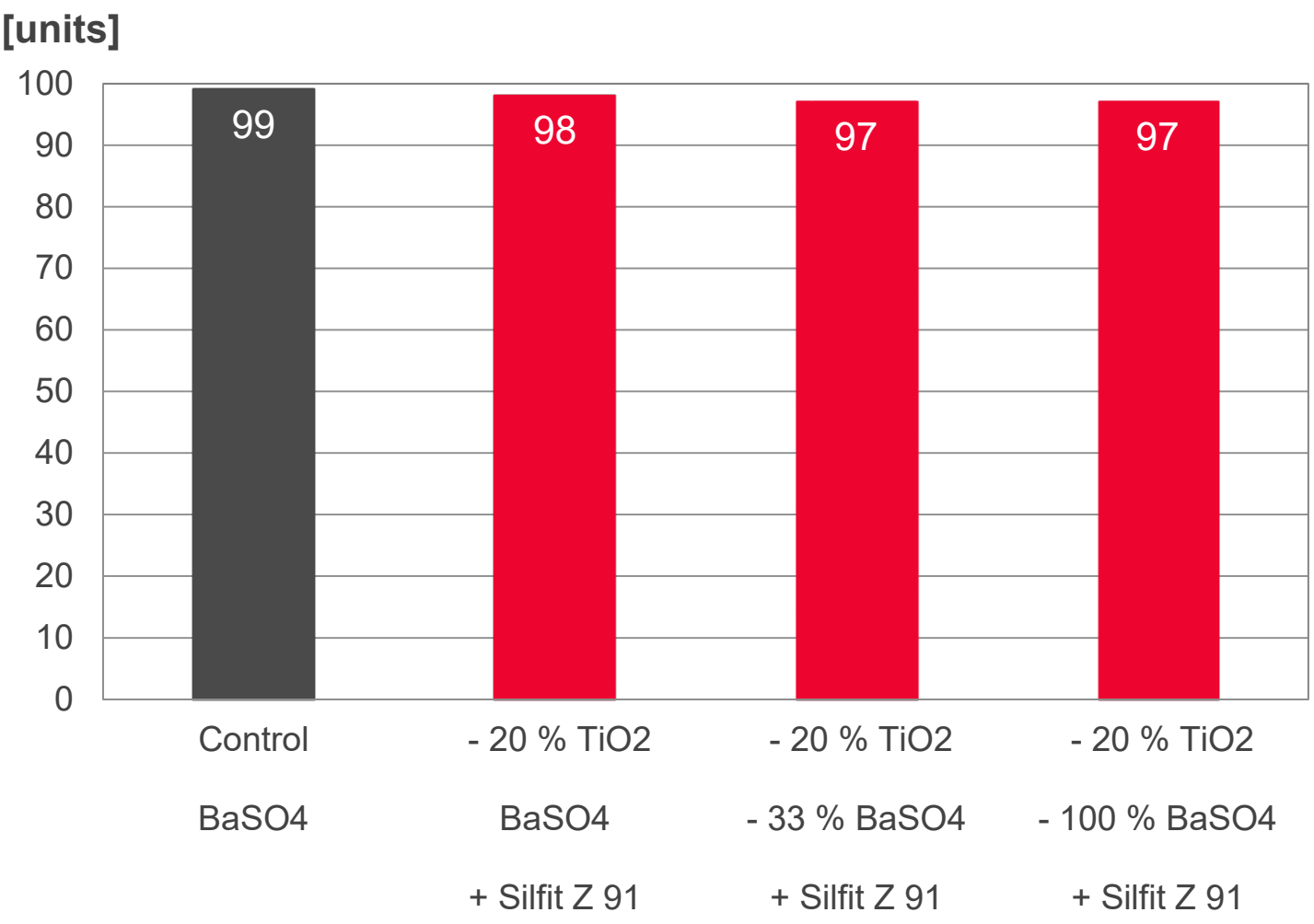
INTRODUCTION

EXPERIMENTAL

RESULTS

- $BaSO_4$ ppt

SUMMARY



Leveling

Appearance of surface (visual assessment)
Substrate: aluminum A 48

	Reflection of overhead light	
Control $BaSO_4$		0
- 20 % TiO_2 $BaSO_4$ + Silfit Z 91		0
- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91		0
- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91		0-

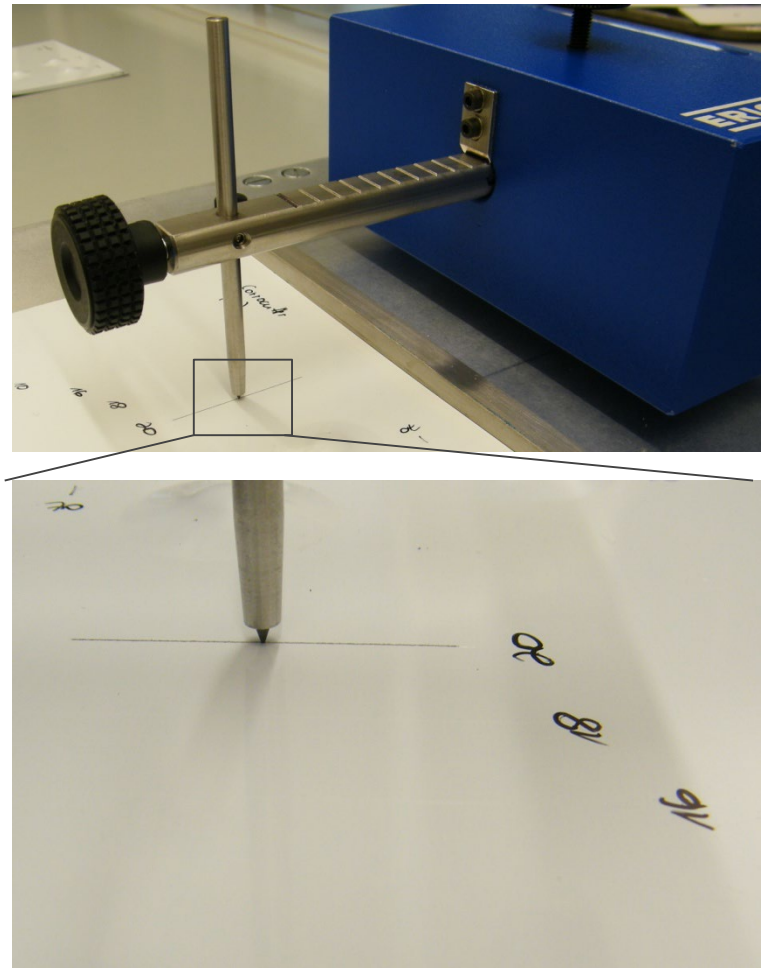
Flexibility

Impact Test ASTM D 2794 (weight: 2 lbs); no visible cracks
Cupping Test DIN ISO 1520
Substrate: aluminum A 36

	Reverse Impact Test [inch pounds]	Cupping Test [mm]
Control $BaSO_4$	16	6.8
- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	10	7.0
- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	14	6.6
- 20 % TiO_2 - 100 % $BaSO_4$ + Silfit Z 91	28	6.4

Mechanical Resistance

Mechanical resistance is tested by scratching the coating down to the substrate with a hard metal tip (substrate: aluminum A 48)



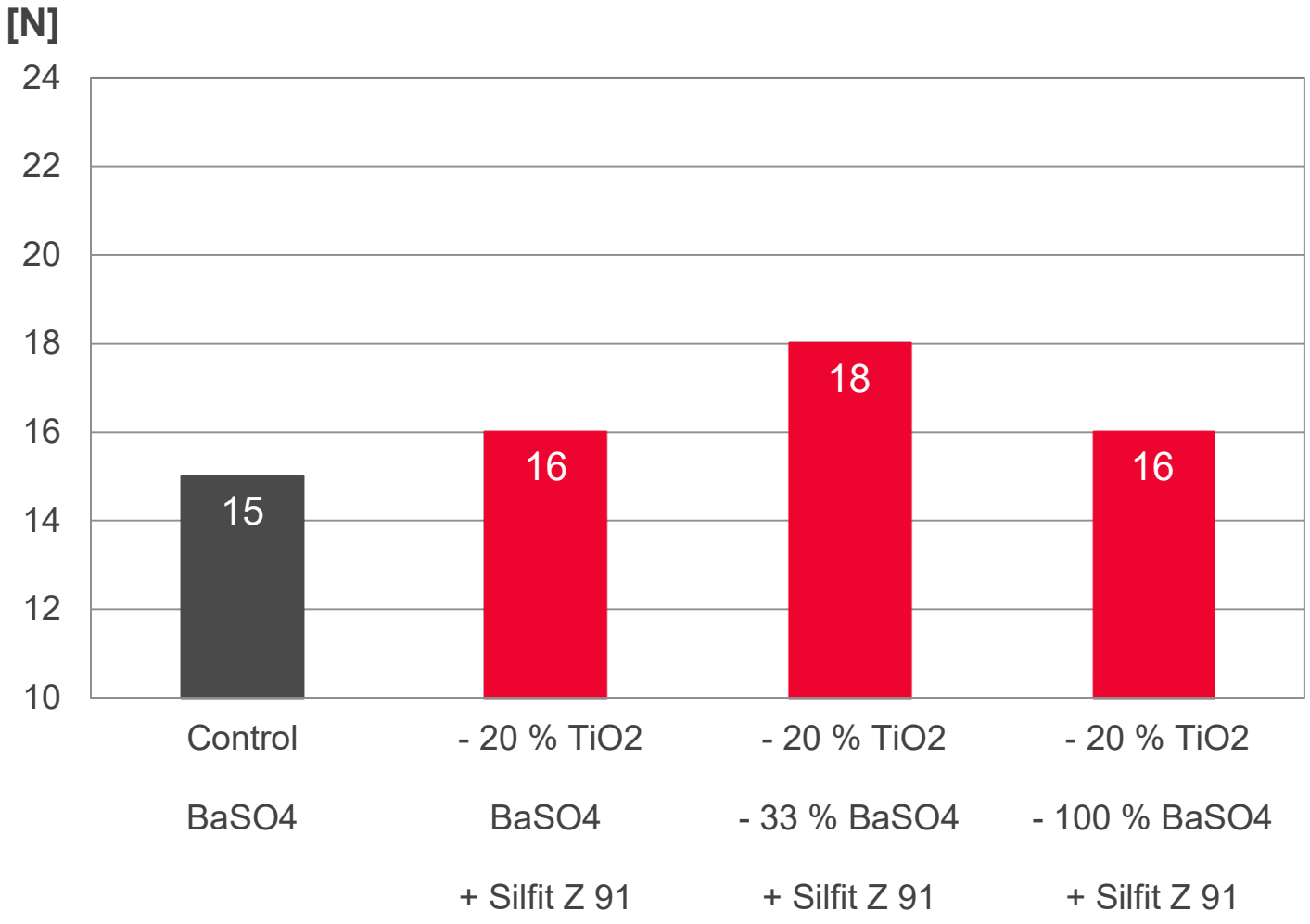
Testing equipment (Erichsen Corrocutter, model 639) with loaded weight, force from 2 – 20 Newton

Round hard metal tip (van Laar, diameter 0.5 mm)

Mechanical Resistance

HOFFMANN MINERAL

Scratch test with Corrocutter



Density

calculated

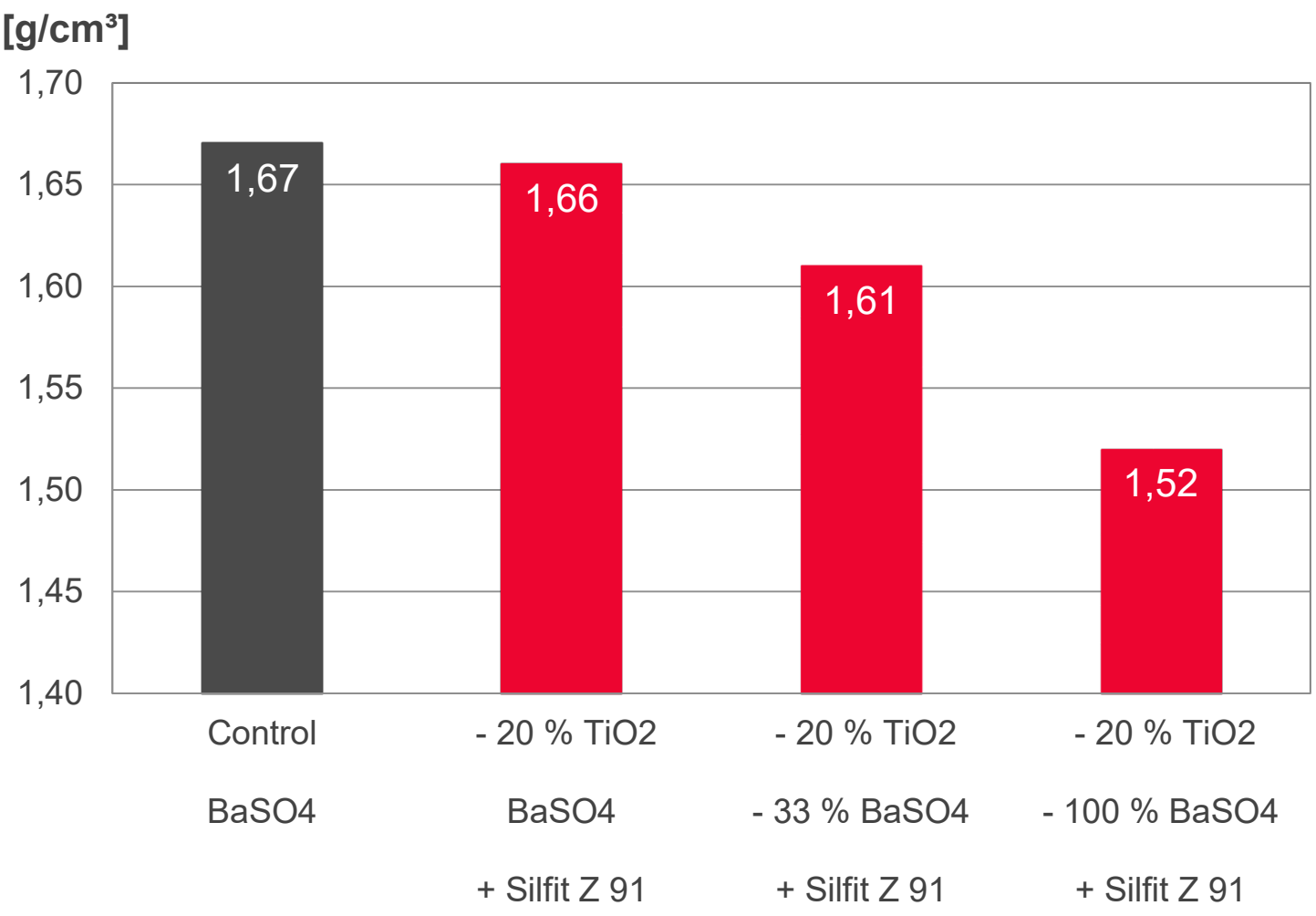
INTRODUCTION

EXPERIMENTAL

RESULTS

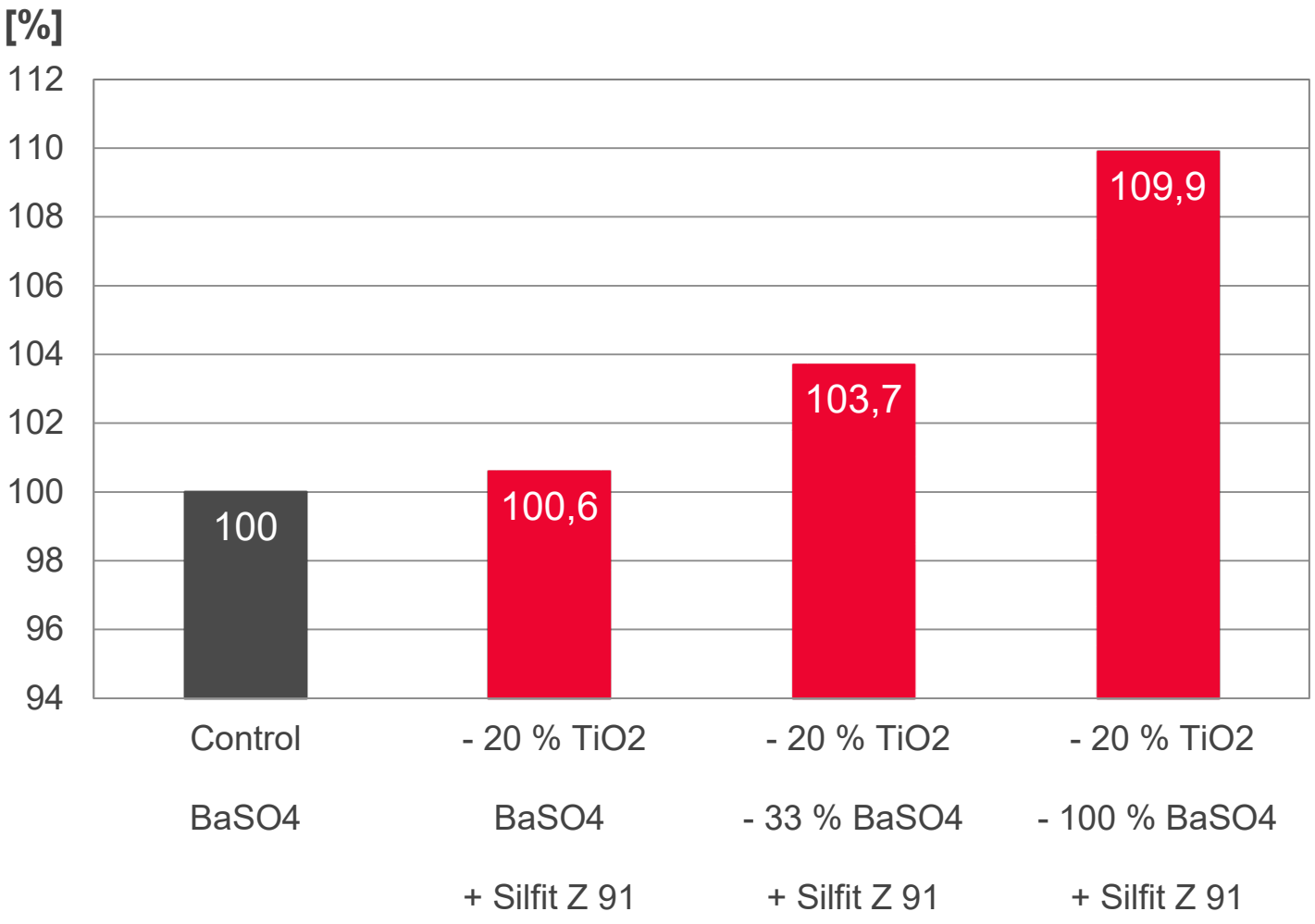
- $BaSO_4$ ppt

SUMMARY



Spreading Rate

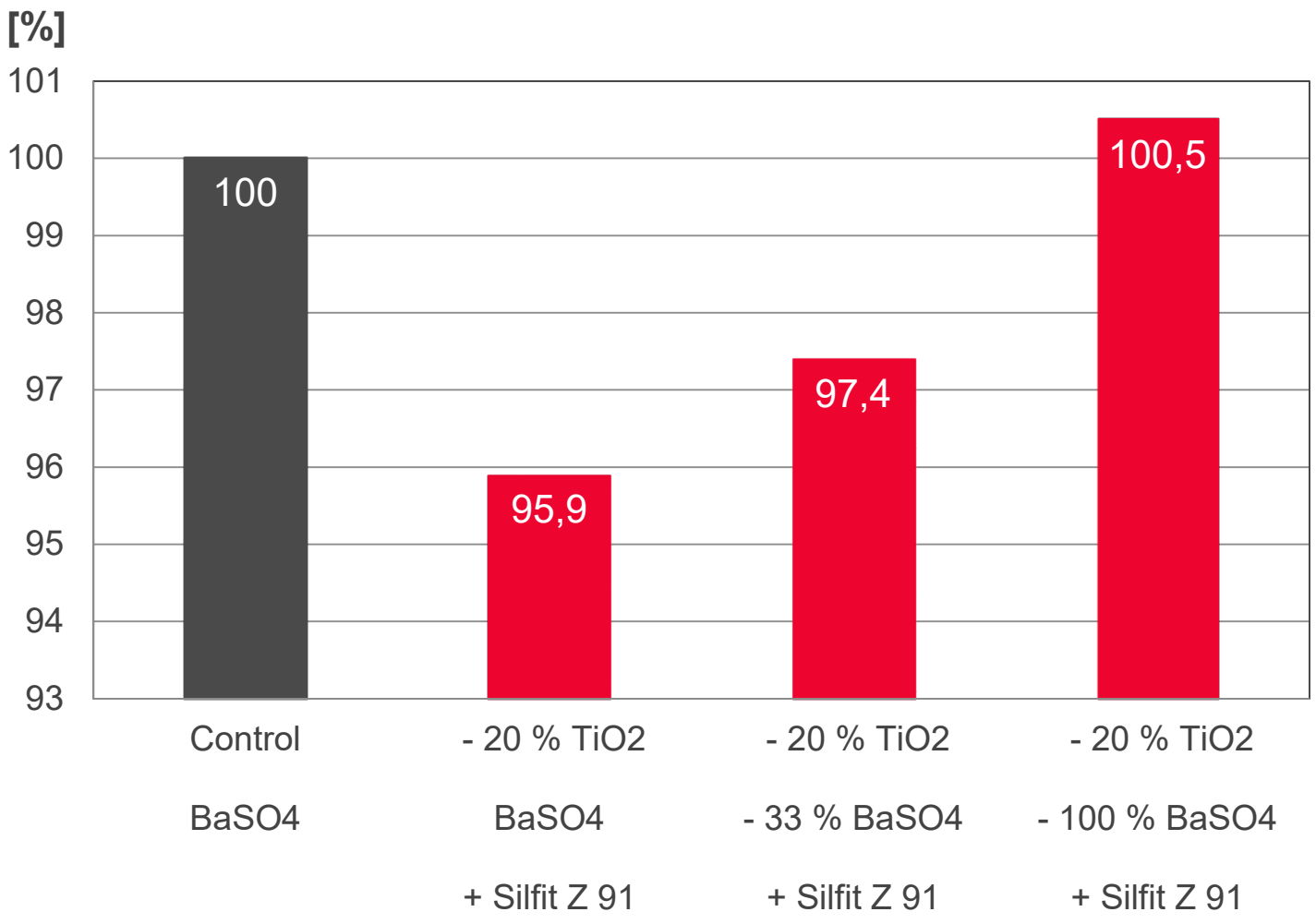
Area coatable per mass unit (e.g. m²/kg powder coating material)



Cost Index
Based on Weight

HOFFMANN MINERAL

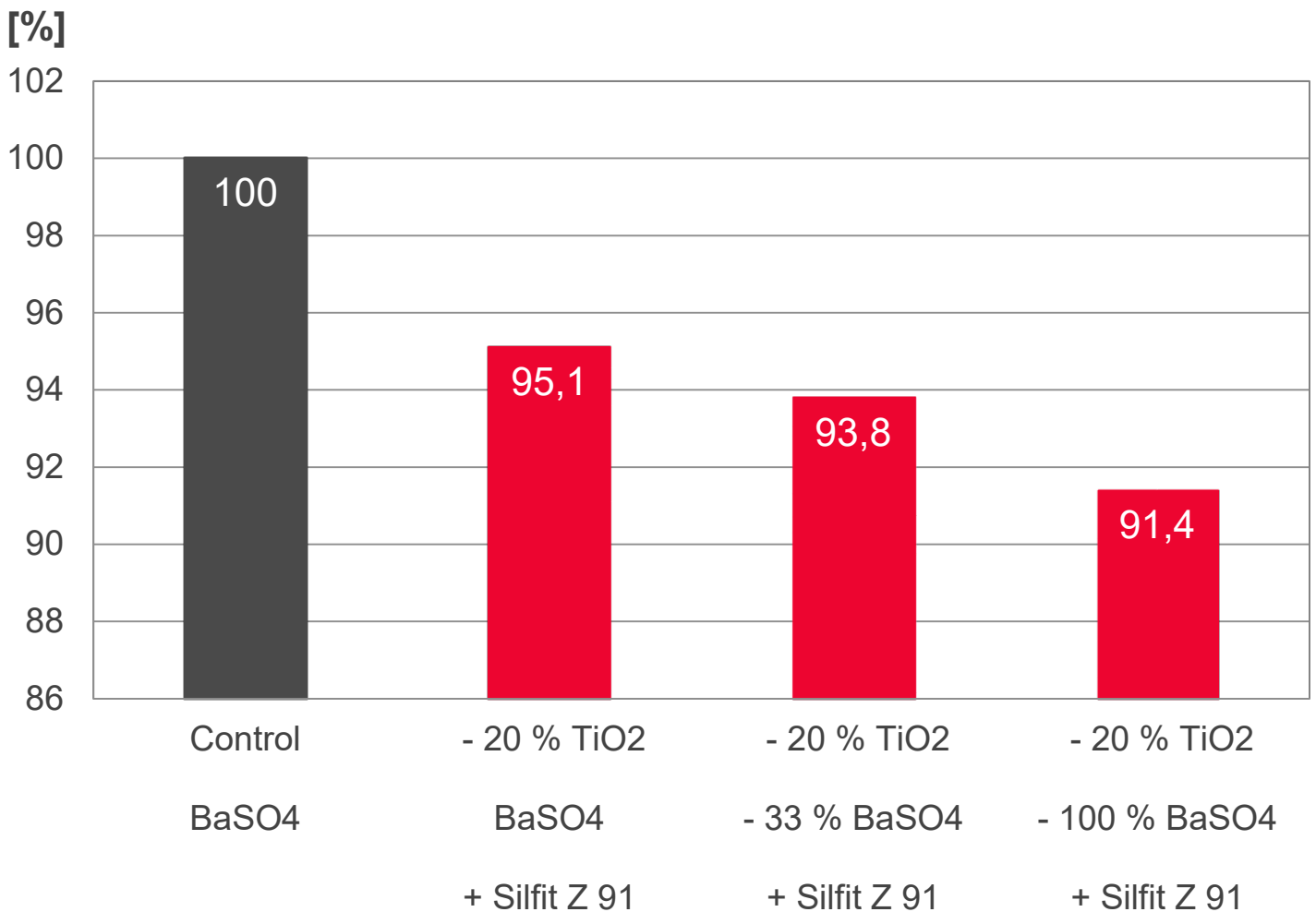
Control = 100 % (Base: Germany 2011)



Cost Index
Based on Volume

HOFFMANN MINERAL

Control = 100 % (Base: Germany 2011)



Summary

Replacement of 20 % titanium dioxide at equal weight with Silfit Z 91 gave rise to the following effects:

- except slightly higher haze, similar optical properties and flexibility

+ slightly improved scratch resistance

+ cost reduction potential

Additionally partial substitution (33 %) of the precipitated barium sulfate by Silfit Z 91 improved furthermore:

+ higher scratch resistance

+ higher spreading rate (lower density of powder coating)

+ cost reduction potential

Conclusion

Independent from the type of barium sulfate, natural or precipitated, it is possible to replace 20 % of titanium dioxide at equal weight with Silfit Z 91 without loosing hiding power. The scratch resistance is enhanced and the costs lowered.

Additional (partial) substitution of the natural barium sulfate by Silfit Z 91 improved the optical properties, scratch resistance, increases the spreading rate and offers cost reduction potential.

Additional partial substitution (33 %) of the precipitated barium sulfate by Silfit Z 91 improved furthermore the scratch resistance, increases the spreading rate and offers cost reduction potential.

Abrasivity
Einlehner-Test

Variations of titanium dioxide / filler (parts per weight in formulation)

	Control $BaSO_4$	- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	- 40 % TiO_2 + Silfit Z 91	TiO_2
				in addition only for Einlehner test	
Titanium dioxide	19.5	15.6	15.6	11.7	39.5
$BaSO_4$ natural	20	20	13.4	20	0
Silfit Z 91	-	3.9	7.8	7.8	0
Einlehner Abrasivity [mg]	51	54	54	54	62

Abrasivity
Einlehner-Test

HOFFMANN MINERAL

Variations of titanium dioxide / filler (parts per cent)

	Control $BaSO_4$	- 20 % TiO_2 $BaSO_4$ + Silfit Z 91	- 20 % TiO_2 - 33 % $BaSO_4$ + Silfit Z 91	- 40 % TiO_2 + Silfit Z 91	TiO_2
				in addition only for Einlehner test	
Titanium dioxide	49.4	39.5	42.4	29.6	100
$BaSO_4$ natural	50.6	50.6	36.4	50.6	0
Silfit Z 91	-	9.9	21.2	19.7	0
Einlehner Abrasivity [mg]	51	54	54	54	62