



工业漆
INDUSTRIAL COATINGS

Hidden inside – Performance outside!



The Mineral Engineers

A DIVISION OF QUARZWERKE GROUP

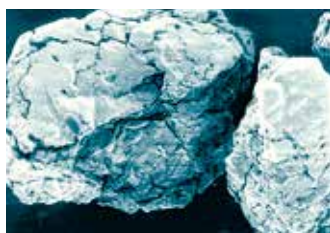


石英、方英石、石英制品： AMOSIL®, SIKRON®, SILBOND®

- 高莫氏硬度
- 高化学耐抗性
- 光学性能优异



石英 | quartz



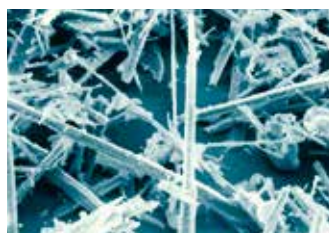
方英石 | cristobalite

Quartz, cristobalite, fused silica: AMOSIL®, SIKRON®, SILBOND®

- high Mohs hardness
- high chemical resistance
- favorable optical properties

硅灰石： TREMIN® 283, 939

- 低莫氏硬度
- TREMIN® 939 :
针形颗粒 (L/D:8:1) HAR
- TREMIN® 283 :
块状颗粒 (L/D:3:1) LAR



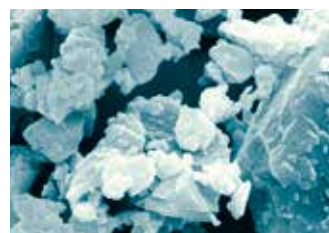
TREMIN® 939

Wollastonite: TREMIN® 283, 939

- low Mohs hardness
- TREMIN® 939: angular particles
(aspect ratio 8:1) HAR
- TREMIN® 283: blocky particles
(aspect ratio 3:1) LAR

长石、霞石正岩： MICROSPAR®, TREMINEX®

- 中莫氏硬度
- 高化学耐抗性
- 光学性能优异
- 片状颗粒



TREMINEX®

Feldspar, nepheline syenite: MICROSPAR®, TREMINEX®

- medium Mohs hardness
- high chemical resistance
- favorable optical properties
- platelet-like particles

工业漆中高性能填料特性：

- 表面硬度高
- 配方成本低
- 为防腐系统创造优越的前提条件、因为：
 - 耐气候性出色
 - 改善了粉化稳定性

Features of high-performance fillers in industrial coatings:

- high surface hardness
- cost-efficient formulation
- excellent requirements for anti-corrosion systems because of:
 - an outstanding weather resistance
 - an increasing chalk resistance

适合工业用途的高性能填料

High-performance fillers for industrial applications

云母： TREFIL® 1232

- 低莫氏硬度
- 耐热性高
- 吸油值低
- 颜色：白云母：白色至浅灰色、金云母：米色至棕色
- 片状颗粒



TREFIL® 1232

Mica: TREFIL® 1232 phlogopite

- low Mohs hardness
- high thermal stability
- low oil absorption
- color: muscovite: white to light grey, phlogopite: beige to brown
- platelet-like particles

硬石膏： TREFIL® 1313

- 低莫氏硬度
- 光学性能优异
- 块状颗粒



TREFIL® 1313

Anhydrite: TREFIL® 1313

- low Mohs hardness
- favorable optical properties
- tabular structure

滑石粉： TIKRON®

- 极低莫氏硬度
- 化学惰性
- 片状颗粒



TIKRON®

Talc: TIKRON®

- very low Mohs hardness
- chemically inert
- very pronounced platelet structure



表面处理

Surface treatment

聚合物-填料界面是潜在的薄弱点。水分或化学品渗透到涂层中、导致腐蚀、起泡和失去附着力、因此、无机填料的系统改善功能显然不能完全发挥出来。

通过用硅烷或硅烷化合物对矿粉进行表面处理、会减少界面的干扰。

硅烷是双官能化合物、由稳定的有机官能团和可水解的活性端基组成。可水解基团与填料表面结合、而有机官能团则与聚合物共混。不同的硅烷、如环氧树脂和氨基硅烷、在实际应用中已充分验证。

Potential weak points can be formed at the interfaces of the polymer-filler system. Moisture or chemicals can e.g. permeate into the coating which causes corrosion, blistering and loss of adhesion, so that the system-improving properties of the inorganic filler obviously cannot be fully exploited.

By surface treatment of mineral flours with silanes or silane based compounds, these interfering effects at the interfaces can be minimized.

Silanes are bifunctional compounds that consist of stable organofunctional and hydrosable reactive terminal groups. The hydrosable group combines with the filler surface, while the organofunctional groups harmonize with the organic binder. Different silanes as epoxy- and aminosilanes are well proven for surface treatment of our high-performance fillers.

应用推荐

何种表面修饰对于某种聚合物能给出最佳结果、必须通过实验验证。

Recommended applications

The most reliable way to find out which coating produces the best results for a specific polymer is by experiment.

聚合物系统 polymer systems	产品标识 labelling
EP, EPDM, FA, MF, PA, PC, PE, PF, PP, PUR, PVC, UF, 聚砜 polysulfone, 水性分散 aqueous dispersions	- AST
ABS, EP, MF, UP, SAN, PA, PC, PE, PF, PP, PS, PUR, PVC, 醇酸树脂 alkyd resins, 多硫化物 polysulfide, 水稀释系统 water-dilutable systems	- EST
EP, PE, PMMA, PP, PS, SAN, UP	- MST
硅橡胶 silicone rubber	- RST / - TST
EPDM, EPM, EPT, PDAP, PE, PP, SBR, UP	- VST

表面修饰提高防腐性能

在用于金属表面的环氧树脂粉末漆中填加硅烷化填料（SILBOND® 石英、SILBOND® 方英石、SILBOND® 熔融二氧化硅、TREMIN® 硅灰石）、可以获得以下方面的改进：

- 提升防腐性能
- 提高耐温性
- 优化填充度
- 改善阴极分层耐性

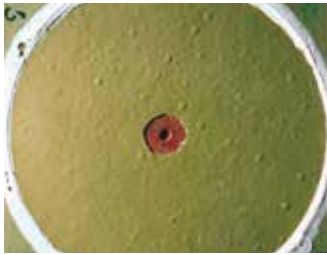
Improved corrosion protection with selective surface treatment

With surface treated, silica based, micronized flours (SILBOND® silica, SILBOND® cristobalite, SILBOND® fused silica, TREMIN® wollastonite) EP-powder-coatings for exterior coatings of metals can be produced. These coatings are characterized by

- increased protection against corrosion
- high temperature resistance
- optimized filling degree
- enhanced resistance regarding the cathodic delamination

表面处理产品实现更好的化学耐性

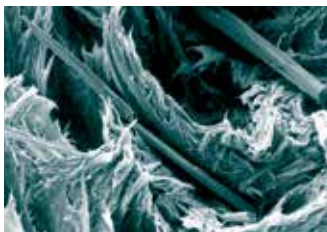
Surface treated products for better chemical resistance



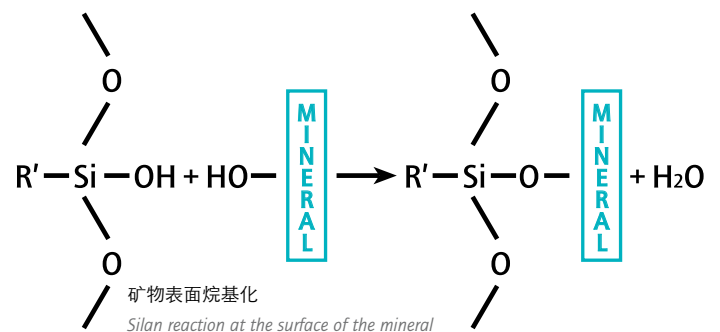
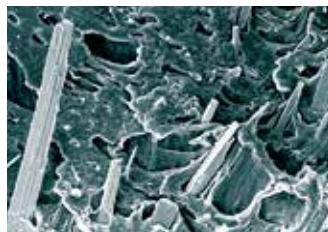
*阴极放电法测试对比两种EP 粉末涂层、一种填充了未处理的硅微粉（SIKRON® SF 600）、另一种填充了硅烷处理的硅微粉（SILBOND® 600 EST）。

*Comparative test of two EP-powder-coatings, one filled with untreated silica flour (SIKRON® SF 600), the other with silane treated silica flour (SILBOND® 600 EST), tested by cathodic disbonding method.

TREMIN® 939
未经过硅烷化处理 | not silanised
聚丙烯中、断裂后横截面
in polypropylene after tough fracture



TREMIN® 939
经过硅烷化处理 | silanised
聚丙烯中、断裂后横截面
in polypropylene after tough fracture





环保防腐

Environmentally friendly corrosion protection

有效的腐蚀保护可以避免工厂和建筑物的频繁维修工作、以及过早更换经常暴露在高湿度或污染物中的维修密集型部件。此外、避免由腐蚀引起的高成本。一段时间以来、环境因素对于含锌防腐颜料的新配方开发起了重要推动作用。自2004年以来、传统的锌基产品已被归类为对环境有害物质。

磷酸锌在防腐配方中被以下矿物填料所取代。除了良好的防腐效果和环境友好之外、配方也进一步简化、更具成本效益。

因此、我们的高性能填料为无锌防腐涂料配方提供了环境相容性和成本效益、例如用于建筑行业、农业设备、建筑机械或暴露在恶劣气候条件下的部件的防腐涂料。

Effective corrosion protection prevents frequent maintenance work on plants and buildings and the premature replacement of maintenance-intensive components that are often exposed to high levels of humidity or pollutants. In addition, high costs caused by corrosion can be avoided. The environmental factor has played a significant role for some time now, so that development work is moving towards new formulations to save zinc-containing corrosion protection pigments. Conventional zinc-based products have been classified as hazardous to the environment since 2004.

Zinc phosphates were replaced by mineral fillers in the following corrosion protection systems. In addition to good corrosion protection results and exemplary environmental friendliness, formulation can be simplified and made more cost-effective.

Our high-performance fillers thus offer an environmentally compatible and cost-effective solution for zinc-free formulation of corrosion protection coatings for example for the construction industry, agricultural equipment, construction machinery or components exposed to aggressive climatic conditions.

有效防腐
水性双组份 EP 涂料

Effective corrosion protection in
2C water borne EP coating system

在下面的环氧防腐涂层中、防腐颜料被矿物填料
或填料组合完全或部分替代：

In the following epoxy-anti-corrosion system the anti-corrosion
pigment has been replaced partially or completely by different
mineral fillers or filler combinations:

组份 component	位置 item	产品 product	[质量 %] [wt.%]
A	1	Anquamine 701 硬化剂 curing agent: Anquamine 701	28.00
	2	Anquamine 701 硬化剂 curing agent: Anquamine 401	10.00
	3	去离子水 VE-water	10.00
	4	消泡剂 Tego Dispers 760 W defoamer Tego Dispers 760 W	1.00
	5	消泡剂 Tego Airex 902 W defoamer Tego Airex 902 W	1.00
	6	防腐颜料 anti-corrosion pigment	6.00
	7	滑石粉 talc	5.00
	8	颜料 pigment	11.00
	9	填料 filler	20.00
	10	防蚀剂 W ‘Add 8905	0.50
	11	有机硅表面活性剂 Byk 348 silicone surfactant Byk 348	0.50
	12	去离子水 VE-water	6.00
	13	硅烷 DOW DC-Z 6011 Silane DOW DC-Z 6011	1.00
			100
B	14	环氧树脂乳化剂 Araldite PZ 756-67 W epoxy resin emulsion Araldite PZ 756-67 W	
		组份混合比例 mixture ratio of components A:B	70:30

在实验中使用以下高性能填料：
The following high-performance fillers were used in the conducted examinations:

TREMIN® 283 短针硅灰石 short-needled wollastonite	TREFIL® 1232 金云母 phlogopite mica	Kaolin TEC FK 高岭土 kaolin
		

填料 filler	d ₅₀ [µm]	颗粒形貌 particle shape	密度 density [g/cm³]	表面处理 surface treatment
天然硫酸钡 natural baryte BaSO ₄	3*	块状 nodular	4.20	—
TREMIN® 283-100	12**	短针式 short needled	2.85	—
TREMIN® 283-100 AST	12**	短针式 short needled	2.85	x
TREFIL® 1232-400	13**	片状 platelet	2.80	—
TREFIL® 1232-400 AST	13**	片状 platelet	2.80	x
高岭土 TEC FK Kaolin TEC FK	2.5**	片状 platelet	2.60	—

测量方法 | method of measurement: *激光衍射 | laser diffraction **沉降图 | sedigraph

我们在检测实验室内对 24 种不同的配方进行了检测、配方中的防腐颜料完全或部分被不同的高性能矿物填料取代。滑石粉和颜料浓度始终保持与起始配方相同。下面介绍了有最好结果的四个配方。

In our test laboratory, 24 different formulations have been tested in which the anti-corrosion pigment was completely or partially replaced by various mineral high-performance fillers. The talc and pigment concentration remained identical to the starting formulation. The four recipes with the best results are presented below.

配方 formulation	0	1	5	18	20
防腐颜料 填料混合物 anti-corrosion pigment filler combinations	质量% wt.%				
无锌防腐颜料 anti-corrosion pigment zinc-free	6				
含锌防腐颜料 anti-corrosion pigment containing zinc		6	2.5		
天然硫酸钡 natural baryte BaSO ₄	20	20			
TREMIN® 283-100			13.5		
TREMIN® 283-100 AST				16	21
TREFIL® 1232-400			10		
TREFIL® 1232-400 AST				10	
Kaolin TEC FK					5
液态漆的属性 properties of the liquid lacquer					
粘度* viscosity* 组份 A component A [Pa*s]	4.89	8.32	7.09	3.16	3.77
密度 density according to DIN 35217 组份 A component A [g/cm ³]	1.46	1.46	1.41	1.44	1.39
产量 yield 在 120 µm 干膜中 at 120 µm dry film [g/m ²]	307.31	307.31	291.56	290.76	290.76

*粘度计 Haake VT 500、试样 E-30、检测速度：5 级 | Viskosimeter Haake VT 500, test specimen E-30, test speed: 5

涂料制备

两组份按照 A 70 :B 30 的混合比例充分混合。适用期：50 - 60 分钟。细度：< 15 µm。干透：24 小时；在 7 天之后满载。喷涂粘度约为 1000 - 1500 mPa*s、可用约 10 % 的稀释剂调节粘度。

Production of lacquers

*The two components were completley mixed with each other at a mixing ratio of A 70 : B 30. Pot life: 50 - 60 min / Grain fineness: < 15 µm. Through-drying: 24 hours; fully loadable after 7 days. A spray viscosity of approx. 1000 - 1500 mPa*s was adjusted with approx. 10 % diluent.*











加工和光学性能说明

在1.8bar的压力下、涂料经由用1.4毫米的喷嘴喷涂在喷砂处理的薄钢板（Sa 2 1/2）上。涂料的喷涂性能和流动性极佳。干燥后表面无缺陷。涂料在腐蚀测试前附着力优异、GT 0。无表面处理的TREFIL®云母和高岭土的光泽度降低明显。与参考样品0相比、填料未影响涂层的亮度L*。

Description of processing and optical properties

The paints were sprayed with a 1.4 mm nozzle at 1.8 bar onto thin, blasted steel sheets (Sa 2 1/2). The spraying behaviour of the paints and the flow of the paint surface were very good. The surface showed no surface defects after drying. The adhesion of the paints before the corrosive load is excellent with GT 0. The gloss is greatly reduced with the uncoated fillers TREFIL® phlogopite and kaolin. The brightness L remains unaffected by the addition of fillers compared to the reference sample 0.*

结果概览
Results at a glance

结果 results	依据 DIN 50021 的盐雾测试 salt spray test according to DIN 50021 500 h				
配方 formulation	0	1	5	18	20
干涂层厚度 dry film thickness [µm]	120				
起泡度和大小 degree and size of blistering	2 (S4)	0 (S0)	0 (S0)	0 (S0)	0 (S0)
腐蚀度 (锈) level of corrosion (rust)	Ri0	Ri0	Ri0	Ri0	Ri0
网格切割测试 cross cut test	GT4	GT4	GT0	GT0	GT0
刮划后板上的腐蚀 (度) corrosion at scribed panel (degree)	1	2	1	1	1
防腐 anti-corrosion	X	X	✓	✓	✓
					
结果 results	依据 DIN EN ISO 6270-2 的冷凝水测试 condensation water test according to DIN EN ISO 6270-2 250 h				
配方 formulation	0	1	5	18	20
干涂层厚度 dry film thickness [µm]	120				
起泡度和大小 degree and size of blistering	2 (S3)	2 (S2)	0 (S0)	0 (S0)	0 (S0)
腐蚀度 (锈) level of corrosion (rust)	Ri0	Ri0	Ri0	Ri0	Ri0
防腐 anti-corrosion	X	X	✓	✓	✓
					

结论

以下填料组合已通过防腐测试、因此不再需要使用防腐颜料：

TREMIN®283-100 AST 和 TREFIL®1232-400 AST

TREMIN®283-100 AST 和 Kaolin TEC FK

未经表面处理的 TREMIN® 283-100 与 TREFIL® 1232-400填料组合、可取代一半以上的防腐颜料。

Conclusion

The following filler combinations have passed the corrosion protection test and make the use of the corrosion protection pigment superfluous:

- TREMIN® 283-100 AST and TREFIL® 1232-400 AST
- TREMIN® 283-100 AST and Kaolin TEC FK

The filler combination of the uncoated grades TREMIN® 283-100 and TREFIL® 1232-400 makes it possible to reduce the proportion of corrosion protection pigment by more than half.



无溶剂双组分环氧重防腐涂料

Solvent free 2C-EP coating system
for heavy duty anti-corrosion

为了节省或完全取代无溶剂双组份环氧树脂涂料体系中的磷酸
锌、测试了不同防腐颜料和填料组合。

In order to save or completely replace zinc phosphate in a solvent-free
2K epoxy resin coating system, various fillers were tested in combination
with and without corrosion protection pigment.
The following starting formulation was used as a basis:

基础配方如下：

组份 component	位置 item	产品 product	[质量 %] [wt.%]
A	1	树脂 resin: Araldite GY 253	48.00
	2	流变添加剂 rheological additive: Bentone SD 2	3.00
	3	防腐颜料 anticorrosion pigment	12.00
	4	滑石粉 talc	8.00
	5	颜料 pigment	5.00
	6	填料 fillers	21.90
	7	消泡剂 defoamer: Tego Airex 900	0.30
	8	消泡剂 defoamer: BYK 085	0.30
	9	流平剂 leveling agent: BYK 354	1.50
			100
B	10	硬化剂 hardener Aradur 223	
		成份的混合比例 Mixture ratio of components A:B	75:25

在实验中使用以下高性能填料：

The following high-performance fillers were used in the conducted examinations:

SILBOND® 126 EST 石英粉末 silica flour	Mikhart 2 CaCO ₃
	

填料 filler	d ₅₀ [µm]	粒形 particle shape	密度 density [g/cm ³]	表面处理 surface treatment
天然硫酸钡 natural baryte BaSO ₄	3*	块状 nodular	4.20	—
石英粉末 silica flour	3*	块状 nodular	2.65	—
Mikhart 2 CaCO ₃	3*	块状 nodular	2.70	—
SILBOND® 126 EST	22*	块状 nodular 双峰分布 bimodale	2.80	x

测量方法 | method of measurement: *激光衍射 | laser diffraction

测试不同防腐颜料与填料的组合。
所有中配方中滑石粉和颜料含量保持不变。表中列出两个最佳配方。

Various combinations of anti-corrosion pigment and fillers have been tested. The talc and pigment concentration remained identical to the starting formulation. The two recipes with the best results are presented below.

配方 formulation	0	2	3
防腐颜料 填料混合 anti-corrosion pigment filler combinations	[质量 %] [wt.%]		
磷酸锌 zinc phosphate	12.00	6.00	
BaSO ₄ 天然硫酸钡 natural baryte	10.00		
石英粉末 silica flour	9.00		
Mikhart 2 碳酸钙 calcium carbonate	2.90		
SILBOND® 126 EST 表面处理的石英粉末 surface treated silica flour		27.90	33.90
液态漆的属性 properties of the liquid lacquer			
粘度* viscosity* 组份 A component A [Pa*s]	25.70	20.20	18.30
密度依据 density according to DIN 35217 组份 A component A [g/cm ³]	1.49	1.47	1.47

*粘度计 Haake VT 500、试样 E-30、检测速度：5 级
*Viskosimeter Haake VT 500, test specimen E-30, test speed: 5




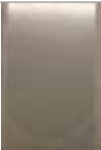

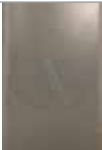
涂料制备
两组分按照比例A 75 :B 25 充分混匀。适用期：35 - 40分钟。干燥：24 小时；在 7 天之满载。约 5 % 的稀释剂调整喷涂粘度约 2000-2500 mPa·s。

Production of lacquers
The two components were completely mixed with each other at a mixing ratio of A 75 : B 25. Pot life: 35 - 40 min. Through-drying: 24 hours; fully loadable after 7 days. A spray viscosity of approx. 2000-2500 mPa*s was adjusted with approx. 5 % diluent.

加工和光学性能说明
用 2 mm 喷嘴在 2 bar 压力下将油漆喷涂经过喷砂的薄钢板(Sa 2 1/2) 上。涂料的涂装性能极佳、油漆表面流平性好。干燥后、表面没有无缺陷。油漆在腐蚀测试前附着力极好、为 GT 0级。所有涂料光泽度较高。与参考样品相比、亮度 L* 不受填料影响。

Description of processing and optical properties
The paints were sprayed with a 2 mm nozzle at 2 bar onto thin, blasted steel sheets (Sa 2 1/2). The spraying behaviour of the paints as well as the flow of the paint surface was very good. The surface didn't show any surface defects after drying. The adhesion of the paints before the corrosive load is with GTO excellent. The gloss has been greatly reduced with the uncoated fillers TREFIL® phlogopite and kaolin. The brightness L* remains unaffected by the addition of fillers compared to the reference sample 0.

结果概览
Results at a glance

结果 results	依据 DIN 50021 的盐雾测试 salt spray test according to DIN 50021 1000 h		
配方 formulation	0	2	3
干涂层厚度 dry film thickness [µm]	320		
起泡度和大小 degree and size of blistering	2 (S4)	0 (S0)	0 (S0)
腐蚀度 (锈) level of corrosion (rust)	Ri0	Ri0	Ri0
网格切割测试 cross cut test	GT5	GT1	GT1
刮划后板上的腐蚀 (度) corrosion at scribed panel (degree)	2	2	2
防腐 anti-corrosion	X	√	√
			
结果 results	依据 DIN EN ISO 6270-2 的冷凝水测试 condensation water test according to DIN EN ISO 6270-2 1000 h		
配方 formulation	0	1	5
干涂层厚度 dry film thickness [µm]	320		
起泡度和大小 degree and size of blistering	0 (S0)	0 (S0)	0 (S0)
腐蚀度 (锈) level of corrosion (rust)	Ri0	Ri0	Ri0
防腐 anti-corrosion	√	√	√
			

结论

- SILBOND® 126 EST 可以完全替代磷酸锌
- 使用 SILBOND® 126 EST 可简化配方

Conclusion

- Formulating without any zinc phosphate is possible by using SILBOND® 126 EST
- The use of SILBOND® 126 EST simplifies the formulating process



Winterdienst

重防腐高固双组分环氧涂料

2C-EP high solid system
for heavy duty anti-corrosion

高固双组分EP体系中、
高性能填料或填料组合取代玻璃片。

In a 2K-EP High Solid System, the proportion of glass flakes was
to be replaced by high-performance fillers or filler combinations.

基础配方如下：

The following starting formulation was used as a basis:

组份 component	位置 item	产品 product	[质量 %] [wt.%]
A	1	树脂 resin Araldite GZ 290 X 90	25.00
	2	流变添加剂 rheological additive Rheothix 240	0.50
	3	填料 filler 玻璃片 glass flakes	15.00
	4	填料 filler 滑石粉 talc	10.00
	5	颜料 pigment	15.00
	6	填料 fillers	20.00
	7	溶剂 solvent Butanol	3.00
	8	溶剂 solvent Dowanol PM	9.50
	9	消泡剂 defoamer Tego Airex 900	0.25
	10	消泡剂 defoamer Byk 085	0.25
	11	流平剂 leveling agent BYK 354	1.50
			100
B	12	Aradur 450	
		组份混合比例 mixture ratio of components A:B	100:10

在实验中使用以下高性能填料：

The following high-performance fillers were used in the conducted examinations:

SILBOND® 126 EST 石英粉末 silica flour	TREFIL® 1232 金云母 phlogopite mica
	

填料 filler	d ₅₀ [µm]	粒形 particle shape	密度 density [g/cm³]	表面处理 surface treatment
天然硫酸钡 natural baryte BaSO ₄	3*	块状 nodular	4.20	—
玻璃片 glass flakes GF 001	8**	片状 splintery	2.60	—
SILBOND® 126 EST	22*	块状 nodular 双峰分布 bimodale	2.65	x
TREFIL® 1232-400	13**	片状 platelet	2.80	—
TREFIL® 1232-400 EST	13**	片状 platelet	2.80	x

测量方法 | method of measurement: *激光衍射 | laser diffraction, **沉降图 | sedigraph

测试玻璃片和填料组合。
五个最优配方如下：

Different glass flakes and filler combinations have been tested.
The five recipes with the best results are presented below.

配方 formulation	0	2	3	4	5	6
防腐颜料 填料混合 anti-corrosion pigment filler combinations	[质量 %] [wt. %]					
天然硫酸钡 natural baryte BaSO ₄	20		20	20		
玻璃片 glass flakes GF 001	15	15				
SILBOND® 126 EST		20			20	20
TREFIL® 1232-400			15		15	
TREFIL® 1232-400 EST				15		15
液态漆的属性 properties of the liquid lacquer						
粘度* viscosity* 组分 A component A [Pa*s]	11.10	14.50	12.30	11.90	24.10	19.50
密度依据 density according to DIN 35217 组分 A component A [g/cm ³]	1.74	1.64	1.73	1.72	1.63	1.63

*粘度计 Haake VT 500、试样 E-30、检测速度：5 | Viskosimeter Haake VT 500, test specimen E-30, test speed: 5

涂料制备
两组分按照比例A 100 : B 10 充分混匀。适用期：45 - 50分钟。干燥：24 小时；在 7 天之满载。约 5 % 的稀释剂调整喷涂粘度约 2000-2500 mPa·s。

加工和光学性能说明
用 2 mm 喷嘴在 2.4 bar 压力下将油漆喷涂经过喷砂的薄钢板(Sa 2 1/2) 上。涂料的涂装性能极佳、油漆表面流平性好。干燥后、表面没有无缺陷。油漆在腐蚀测试前附着力极好、为 GT 0级。漆面光泽度为中等水平。与参考样品相比、亮度 L* 不受填料影响。

Production of the lacquers
The two components were completley mixed with each other at a mixing ratio of A 100 : B 10. Pot life: 45 - 50 min. Through-drying: 24 hours; fully loadable after 7 days. A spray viscosity of approx. 2000 -2500 mPa*s was adjusted with approx. 5 % deionised water.

Description of processing and optical properties
The paints were sprayed with a 2 mm nozzle at 2,4 bar onto thin, blasted steel sheets (Sa 2 1/2). The spraying behaviour of the paints as well as the flow of the paint surface was very good. The surface didn't show any surface defects after drying. The adhesion of the paints before the corrosive load is with GTO excellent. The gloss has been greatly reduced with the uncoated fillers TREFIL® phlogopite and kaolin. The brightness L* remains unaffected by the addition of fillers compared to the reference sample 0.

结果概览
Results at a glance

结果 results	依据 DIN 50021 的盐雾测试 salt spray test according to DIN 50021 1000 h					
配方 formulation	0	2	3	4	5	6
干涂层厚度 dry film thickness [µm]	320					
起泡度和大小 degree and size of blistering	0 (S0)	0 (S0)	0 (S0)	0 (S0)	0 (S0)	0 (S0)
腐蚀度 (锈) level of corrosion (rust)	Ri0	Ri0	Ri0	Ri0	Ri0	Ri0
网格切割测试 cross cut test	GT1	GT1	GT1	GT1	GT1	GT1
刮划后板上的腐蚀 (度) corrosion at scribed panel (degree)	3	2	3	3	3	3
防腐 anti-corrosion	✓	✓	✓	✓	✓	✓
						
结果 results	依据 DIN EN ISO 6270-2 的冷凝水测试 condensation water test according to DIN EN ISO 6270-2 1000 h					
配方 formulation	0	2	3	4	5	6
干涂层厚度 dry film thickness [µm]	320					
起泡度和大小 degree and size of blistering	0 (S0)	0 (S0)	0 (S0)	0 (S0)	0 (S0)	0 (S0)
腐蚀度 (锈) level of corrosion (rust)	Ri0	Ri0	Ri0	Ri0	Ri0	Ri0
防腐 anti-corrosion	✓	✓	✓	✓	✓	✓
						

结论

配方中的玻璃片可用 TREFIL® 1232-400 金云母替代。

SILBOND® 126 EST 和 TREFIL® 1232-400（有或无表面处理）组合表现出极好的防腐性能。

填料组合的配方同时具有低密度优点、因为可完全取代BaSO₄。

Conclusion

In the recipe the glass flakes can be replaced by TREFIL® 1232-400 phlogopite mica.

The filler combination of SILBOND® 126 EST and TREFIL® 1232-400 (with and without surface treatment) shows very good corrosion protection properties.

The formulation with the filler combination also has the advantage of lower density, since BaSO₄ can be replaced completely.



降低VOC *VOC reduction*

双组份 EP 高固系统中添加 TREFIL® 1313-600

在降低涂料中挥发性有机物质准则的背景下、高固体系能够出色满足要求。该类面漆VOC含量的最高限值为300 g/l（依据ChemVOCFarbV、自2010年1月1日起生效）。

基于天然硫酸钙（硬石膏）的TREFIL® 1313-600 和表面处理的产品、不但能够提高光学、机械性能和防腐性能、还能减少挥发性有机物质含量。同时降低配方成本。

Functional Filler TREFIL® 1313-600 in 2K-PU High Solid systems

Against the background of the VOC Directive to reduce the emission of volatile organic compounds in paints, High Solid systems are an excellent way for a VOC-compliant coating. The maximum VOC content of such topcoats is 300 g/l (valid from 1st January 2010 according to ChemVOCFarbV).

With formulations containing TREFIL® 1313-600 and its surface-treated type, based on a natural calcium sulfate (anhydrite), it is possible to increase optical, mechanical and anti-corrosion properties and at the same time reduce volatile organic compounds. In addition cost-efficiency can be achieved.

配方 | *formulation*

配方 <i>formulation</i>			1	2	3
原料 <i>raw material</i>	功能 <i>function</i>	供应商 <i>supplier</i>	[质量 %] <i>[wt.%]</i>	[质量 %] <i>[wt.%]</i>	[质量 %] <i>[wt.%]</i>
Synthalat A-149 HS	树脂 <i>resin</i>	Synthopol Chemie	55.00	55.00	55.00
Solventnaphta	溶剂 <i>solvent</i>	Brenntag	4.70	4.70	4.70
Tixogel MP 100	流变添加剂 <i>thickener</i>	Rockwood Additives	0.50	0.50	0.50
BYK AT 203	耦联添加剂 <i>wetting additiv</i>	Byk Chemie	0.50	0.50	0.50
二氧化钛 <i>Titandioxid</i>	颜料 <i>pigment</i>	Kronos Titan	15.00	15.00	15.00
BYK 057	消泡剂 <i>defoamer</i>	Byk Chemie	0.65	0.65	0.65
BYK S 706	流平剂 <i>leveling agent</i>	Byk Chemie	0.65	0.65	0.65
合成硫酸钡 <i>synthetic barium sulphate</i>	填料 <i>filler</i>	若干	23.00	-	-
TREFIL® 1313-600 硬石膏 <i>anhydrite</i>	可选填料 <i>alternative filler</i>	Quarzwerke	-	23.00	-
TREFIL® 1313-600 EST/2 硬石膏 <i>anhydrite</i>	可选填料 <i>alternative filler</i>	Quarzwerke	-	-	23.00
Desmodur N 3390	硬化剂 <i>hardener</i>	Bayer Material Science	4:1	4:1	4:1
油漆属性 / 可加工性 / 生产率 <i>properties of the laquer / processibility / yield</i>					
混合密度 [g/cm³] <i>density mixture [g/cm³]</i>			1.35	1.31	1.31
固体 [质量 %] <i>solid content [wt.%]</i>			83.92	83.92	83.92
固体 [体积 %] <i>solid content [vol %]</i>			75.42	76.05	76.05
80 µm干膜每平方米消耗量 [g] <i>consumption per (m²) at 80 µm. dry [g]</i>			142.70	137.90	137.90
VOC [g/l]			216.30	210.76	210.76
VOC [g/l]30 秒 <i>with a set efflux time of 30 sec.</i>			301.23	282.02	276.23

双组份 PU 高固面漆 、含合成硫酸钡的基础配方 | *2K- PU High Solid Topcoat, Basic recipe with synthetic barium sulphate*

涂料的制备和施工

- 搅拌器混合均匀、过80 µm快速筛网。熟化24小时。
- 通过刷子涂覆、约 100 µm、干燥、
通过 BYK micro TRI gloss µ 检查
由钢 DC 04 B, 190 x 150 x 0.8 mm 制成的检测板
材、Krüppel 公司（用乙醇脱脂）
干燥条件：在室温 (20°C) 下 3 天、在 40°C 下 24h

*Production and application
of the lacquers*

- *Manufacture of the paints by way of dissolver grinding with subsequent sieving over an 80 µm fast screen. Maturation of the produced batches over 24 hours.*
- *Application by means of brush, approx. 100 µm, dry, control with BYK micro TRI gloss µ
Substrate test plates made of steel DC 04 B, 190 x 150 x 0.8 mm, Krüppel Co. (degreased with ethanol)
Drying conditions: at room temperature (20°C) 3 days, then 24 h at 40°C*



结果概览
Results at a glance

配方 <i>formulation</i>	1	2	3
机械学性能 <i>mechanical properties</i>	合成 <i>syntetic</i> BaSO4	TREFIL® 1313-600	TREFIL® 1313-600 EST/2
König 摆锤硬度 [s] (DIN 53157) <i>pendulum hardness König [s] (DIN 53157)</i>	56	39	59
深冲 <i>cupping</i> [mm] (ISO 1520:1973)	11.90	11.40	11.70
冲击测试 [落差] <i>drop height</i> [mm] (DIN 55669)	100 - 200	< 50	100 - 200

硬石膏赋予优异外观属性
Excellent optical properties due to Anhydrite

外观参数 <i>optical properties</i>			
白背景色值 <i>color values over white</i>	BYK反射雾度计 <i>BYK micro-haze-plus</i>		
L*	95.52	94.67	95.02
A*	-0.83	-0.69	-0.78
B*	1.80	2.19	2.0
光泽度 <i>gloss</i> 20° Ø [%], 7d	70.90	70.80	85.70
雾度 Haze Hlin Ø	5.80	11.60	6.20
雾度 Haze Hlog Ø	103.00	206.00	91.80



与合成硫酸钡相比、TREFIL® 1313-600在双组份 PU 高固面漆中能：

- 显著降低 VOC
- 涂料粘度低且漆面表面属性优异
- TREFIL® 1313-600 EST/2 提高光泽度、降低雾度
- 1000 h 凝水试验、起泡显著减少
- 防腐效果极好
- 提高产率

In comparison to high solid top coats formulated with synthetic barium sulphate, the use of TREFIL® 1313-600 offers the following benefits:

- *noticeable reduction of the volatile organic compounds*
- *superior surfaces through reduced viscosity; the silanized TREFIL® 1313-600 EST/2 features the highest gloss and the lowest haze*
- *clear reduction of blistering after 1000 h condensation water test*
- *enhanced anti-corrosion*
- *increased yield*



优化风电转子叶片涂层系统

Optimized wind turbine blade coatings

海上风机转子叶片设计寿命为无干扰运转20年。它们通常暴露在多种自然环境下：雪、雨、海水、冰雹、热及紫外辐射。叶片尖端风速可高达500 km/h、这是叶片的一个薄弱点。雨蚀也是严苛挑战的一种。

测试成功表明、在转子叶片涂层中添加高性能填料可以提高叶片在高速旋转中抗极端气候的能力。

雨蚀测试基于新开发、模拟真实情况的微型模拟器。涂层由胶衣、底漆和面漆组成、所有的配方基于久经验证的聚天冬氨酸粘合剂。这项预研究对于正确选择底漆中的填料至关重要。雨蚀测试的涂层基于科思创的Pasquick®技术、测试方法根据DnVGL-RP-01。

Offshore rotor blades for wind turbines are built to withstand 20 years of operation without interference. They are exposed to a wide variety of environmental influences such as snow, rain, salty seawater, hail, heat and UV radiation. Wind speeds of up to 500 km/h can act on the blade tips. This area is a weak point of the rotor blade. Rain erosion is one of the greatest stresses.

Successfully passed tests confirm that the addition of high-performance fillers in the coating system for rotor blades improves resistance to harsh weather conditions at higher rotor speeds.

First, initial rain erosion tests were carried out in a newly developed miniature simulator based on real conditions. A coating structure consisting of a gelcoat, primer and topcoat was chosen for the study. All formulations contained polyaspartics-based binders, which have already proven themselves in practice for rotor blade coatings. This pre-study was crucial for the correct selection of fillers in the primer, which are subsequently subjected to the rain erosion test (RET according to DnVGL-RP-0171) in a coating based on Pasquick® technology of Covestro.



结果概览

- 通过实验室规模快速、贴近现实的雨蚀测试、选择恰当的高性能填料
- 通过表面处理、提高高性能填料与聚合物系统匹配性、改善涂层系统的抗性：
 - TREMIN® 283-600 AST（块状硅灰石）
 - SILBOND® 600 AST（角形石英粉末）
- 根据 DNVGL-RP-0171 标准、实验室规模验证 SILBOND® 600 AST
- 底漆中使用SILBOND® 600 AST带来的效果可以传递到整体涂层系统、从而将进一步提高性能

Results at a glance

- *Selection of suitable high-performance fillers possible through fast and realistic rain erosion test on a laboratory scale*
- *Improvement of the resistance of the coating system by using high-performance fillers in the primer with a surface coating adapted accordingly to the polymer system:*
 - *TREMIN® 283-600 AST (cuboid wollastonite)*
 - *SILBOND® 600 AST (angular fine silica powder)*
- *Verification of the determined result in laboratory scale of SILBOND® 600 AST by RET according to DNVGL-RP-0171*
- *The proven advantage of using SILBOND® 600 AST in the primer can be transferred to any other layer within the coating system and can thus lead to a further increase in performance*

实验室规模模拟雨蚀测试

为了研究高性能填料的有效性、底漆配方中的滑石粉和合成硫酸钡等体积被取代、而胶衣和面漆组成不变。

Pre-test by simulating the rain erosion test on a laboratory scale

In order to investigate the effectiveness of the high-performance fillers, they were exchanged for the reference fillers talc and synth. Barium sulphate 1:1 by volume in the starting formulation of the primer. Both the gelcoat and the topcoat remained unchanged in their composition.

微型模拟器中的雨蚀测试
Rain erosion test in miniature simulator

配方：前期测试的底漆配方
Formulation: primer formulation for the pre-test

	原料 raw material	[质量 %] [wt. %]	功能 function
组份A component A	Desmophen NH 1422	36.76	Polyaspartic 粘结剂 binder
	BYK-P 104 S	0.55	润湿剂和分散剂 wetting and dispersing additive
	BYK-066 N	0.55	消泡剂 defoamer
	AEROSIL 720 TS	0.55	硅酸 silicic acid
	SYLOSIV 3A	1.84	分子筛 molecular sieve
	LUVOTIX HT	0.92	蓖麻油衍生物 castor oil derivative
	TiO2	3.68	白颜料 white pigment
	滑石粉	27.57	填料 filler
	合成硫酸钡	27.57	填料 filler
组份B component B	Desmodur N 3300	26.50	硬化剂 hardener



制备
和应用

使用分散机制备所有配方。熟化24小时。小型叶片样品为尺寸为 22 cm x 2.4 cm x 0.4 cm（长 x 宽 x 高）的玻璃纤维增强塑料杆。使用刷子涂布涂层。

模拟再腐蚀

为此以 10,000 U/min 的水平转速在离心分离机中绕着其自身的轴旋转玻璃纤维增强塑料杆。同时使用 3 mm 宽连续水束从上方垂直施加负荷、水束通过一根铝管在需要施加负荷的表面上方 1 cm 处流出。水的流量为 0.5 l/min。其目的是模拟下雨。

Production
and application

All formulations were prepared with a Dispermat. Further processing of the preparations took place after a maturing time of 24 hours. GRP rods with the dimensions: 22 cm x 2.4 cm x 0.4 cm (L x W x D) were used. Application by brush

Simulation of rain erosion:

For this purpose, the GRP rods were rotated around their own axis in a centrifuge at a horizontal rotational speed of 10,000 rpm. At the same time, a vertical load was applied from above with a continuous 3 mm wide water jet, which flowed out through an aluminium pipe 1 cm above the surface to be loaded. The flow volume of water was 0.5 l/min. This served to simulate rain.

10000 rpm 下、时间相关的涂层损坏情况
Time-dependent damage images of the coating at 10,000 rpm

5 min.	8 min.	10 min.
<div>1</div>  <p>滑石粉/合成硫酸钡(BaSO₄)</p>	<div>2</div>  <p>滑石粉/合成硫酸钡(BaSO₄)</p>	
<div>3</div>  <p>TREMIN®</p>	<div>4</div>  <p>TREMIN®</p>	
<div>5</div>  <p>TREMIN® 经过表面处理 surface treated</p>	<div>6</div>  <p>TREMIN® 经过表面处理 surface treated</p>	<div>7</div>  <p>TREMIN® 经过表面处理 surface treated</p>
<div>8</div>  <p>SIKRON®</p>	<div>9</div>  <p>SIKRON®</p>	
<div>10</div>  <p>SILBOND® 经过表面处理 surface treated</p>	<div>11</div>  <p>SILBOND® 经过表面处理 surface treated</p>	<div>12</div>  <p>SILBOND® 经过表面处理 surface treated</p>

为符合DNVGL-RP-0171雨蚀测试选择合适的高性能填料

Pasquick® 技术优势和正确功能填料的组合、可以为转子叶片提供性能更强大的涂层系统。SILBOND® 600 AST 在前期研究中被确定为大有前途的候选材料、可以以相同体积取代底漆中的对照填料、即滑石粉、碳酸钙、高岭土和硫酸钡。胶衣和面漆保持不变。

Choosing the right high-performance filler for RET according to DNVGL-RP-0171

Combining the benefits from Pasquick® technology with the right functional filler results in improved performance of coatings for rotor blades. SILBOND® 600 AST has been identified as a promising candidate in the pre-study and has been substituted 1:1 by volume for the reference fillers in the primer, namely talc, calcium carbonate, kaolin and barium sulphate. Here, too, gelcoat and topcoat remained unchanged.

配方：根据 DNVGL-RP-0171 的雨蚀测试的底漆配方
Formulation: Primer formulation for the rain erosion test according to DNVGL-RP-0171

	原料 raw material	[质量 %] [wt.%]	功能 function
组份 A component A	Desmophen NH 1420	6.0	Polyaspartic 粘结剂 binder
	Desmophen NH 1520	10.9	Polyaspartic 粘结剂 binder
	BENTONE® SD-2	0.4	流变添加剂 rheological additive
	DISPERBYK® 111	0.1	润湿剂和分散剂 wetting and dispersing additive
	BYK® 141	0.3	消泡剂 defoamer
	乙酸丁酯 / 甲基丙炔酸酯 / 二甲苯 Butylacetat / Methylpropylacetat / Xylol	11.4	溶剂 solvents
	BAYFERROX® 318	0.4	黑色颜料 black pigment
	Crenox® R-KB 4	6.9	白颜料 white pigment
	HEUCOPHOS® ZPA	4.4	防腐颜料 anticorrosive pigment
	SYLOSIV® A4	1.1	分子筛 molecular sieve
	HPF 填料* HPF-Füllstoffe*	39.9	填料 fillers
组份 B component B	Desmodur® N 3800	3.0	硬化剂 hardener
	Desmodur® N 3900	9.2	硬化剂 hardener
	乙酸丁酯 / 甲基丙炔酸酯 / 二甲苯 Butylacetat / Methylpropylacetat / Xylol	7.1	溶剂 solvents

*按照体积替换参考填料 | *Conversion of the proportion of reference fillers by volume

测试基于三叶片直升机原理、其中试样反应基材结构的实际叶片。在 Covestro 实验室以三层结构对三个试样进行涂层。

由于涂层系统需要承受极端的气候条件、因此理解其性能和腐蚀性十分重要。因此在 AeroNordic ApS 依据 DNVGLRP-0171 对其进行再腐蚀测试 (RET)。这时气候条件与真实的严苛天气条件极其类似。

The test is based on the principle of a three-bladed helicopter, with the test specimen reflecting the actual blade substrate construction. Three test specimens each were coated with a three-layer structure in the Covestro laboratory.

As the coating systems have to withstand extreme weather conditions, it is important to understand their performance and erosion behaviour. Therefore, they were subjected to the rain erosion test (RET) according to DNVGLRP-0171 at AeroNordic ApS. The weathering conditions here are very similar to real harsh weather conditions.



结果

五小时之后目视检测、含有对照填料涂层的试样出现脱落和腐蚀。击穿定义为首次出现裸露的基底、即腐蚀在整个涂层中延伸。在五小时之后停止测试、并且因整套涂层系统出现疲劳而无法继续。

用底漆配方中、SILBOND® 600 AST 替换对照填料可以带来显著的性能提升、因为该涂层系统不会被击穿。疲劳仅出现在面漆层。

八小时后停止测试过程、未观察到击穿至基底。相比之下、采用对照填料的涂层系统在五小时后已经损坏。

Results

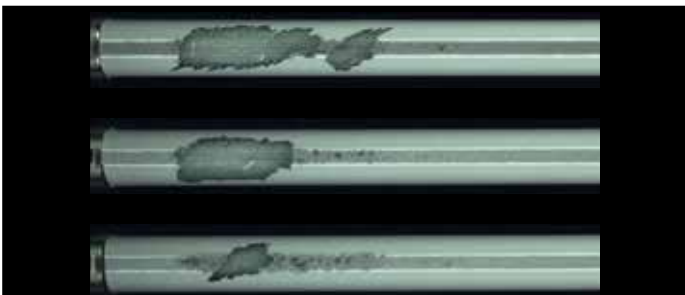
The visual inspection after five hours showed peeling and erosion in the test specimens with the coating containing the reference fillers. Breakthrough is defined as the first appearance of the exposed underlying substrate, meaning the erosion has progressed through the entirety of the layer. The test was stopped after five hours of running and not further continued due to the fatigue of the entire coating system.

The replacement of the standard fillers by SILBOND® 600 AST in the primer formulation has a huge performance benefit as this coating system does not show any breakthrough to the laminate. The fatigue is limited to the topcoat layer only.

The test run was stopped after eight hours of testing, as no breakthrough to the substrate was observed, compared to the coating system with the reference fillers, which was already destroyed after five hours

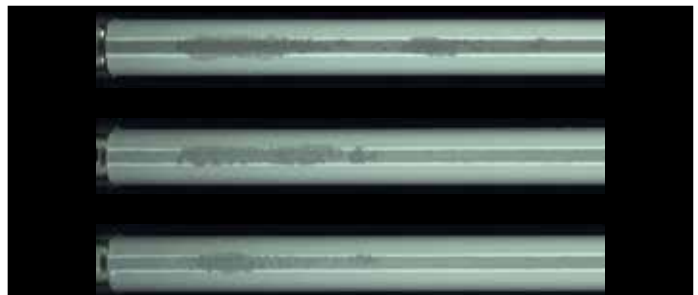
在五小时累积腐蚀时间下、采用对照填料的底漆三层涂层系统的试样图片。

Specimen image of the three-layer coating system consisting of the primer containing the reference filler at an accumulated erosion time of five hours.



在八小时累积腐蚀时间下、采用 SILBOND® 600 AST 的底漆三层涂层系统的试样图片。

Specimen image of the three-layer coating system consisting of the primer containing SILBOND® 600 AST at an accumulated erosion time of eight hours.



我们感谢 DAS Lack GmbH 和 Covestro Deutschland AG 的精诚合作、以及所提供的信息和图片。在 AeroNordics Aps 执行了雨腐蚀测试。

We would like to thank DAS Lack GmbH and Covestro Germany for their excellent cooperation and the information and pictures provided. The rain erosion test has been conducted at AeroNordics Aps.

产品适用于 涂料、油漆和抹灰 Products for paints, coatings and plasters	道路标线 road markings	乳化油漆 dispersion paints	无机颜料 silicate paints	防腐漆 anticorrosive coatings	粉末漆 powder coatings	印刷油墨 inks	木材漆 wood coatings	电绝缘漆 wire coatings	UV 紫外漆 UV curing coatings	工业漆 industrial coatings	乳胶漆 emulsion plasters	彩色抹灰 coloured plasters	硅酸盐抹灰 silicate plasters	矿物抹灰 mineral plasters	粘接剂 adhesives	中值粒径 [µm] median grain size [µm]	密度 [g/cm ³] density [g/cm ³]	莫氏硬度 Mohs hardness	白度 Y 值 各种产品 brightness Y-value of various products	吸油值 oil absorption
石英砂 quartz sand	■										■	■	■	■		80 - 2000	2.65	7	25-50	8
白色石英 white quartz	■										■	■	■			100 - 3000	2.60	7	60 - 68	
彩色石英 coloured quartz	■										■	■					2.60			
AMOSIL®, MILLISIL®, SIKRON®, SIBELITE® 石英、方英石、石英制品 quartz, cristobalite, fused silica	■	■	■	■	■		■	■	■	■	■	■	■	■	■	2 - 70	2.20 - 2.65	6 - 7	67 - 95	21 - 34
硅烷化处理的 SILBOND® silanized 石英、方英石、石英制品 quartz, cristobalite, fused silica	■	■	■	■	■		■	■	■	■	■	■	■		■	2.5 - 40	2.20 - 2.65	6 - 7	71 - 97	11 - 27
TREMIN® 硅烷化处理的硅灰面 surface treated wollastonite		■		■	■										■	2.5 - 99	2.85	4.5	80 - 94	23 - 50
TREMINEX® 硅烷化处理的霞石正长岩 surface treated nepheline syenite					■	■	■		■	■						2 - 32	2.60	6	85 - 93	13 - 27
MICROSPAR® 长石 feldspar		■	■	■	■		■		■	■						0.5 - 10	2.60	6	96 - 97	
Chinafill, AK Pure Gloss 高岭土 kaolin		■	■	■	■	■	■								■	0.5 - 6.5	2.60	2	82 - 88	46 - 56
AK Pure 哑光 + 超哑光 AK Pure matt + supermatt 煅烧 calcinate		■	■								■		■			4 - 6	2.70	7	92 - 94	37 - 42
HYDRAFIL® 氢氧化铝 aluminium hydroxide			■		■	■	■		■	■	■					0.8 - 106	2.40	3	91 - 99	15 - 31
TREFIL® 1232, TREMICA® 云母 mica			■	■	■			■		■	■		■		■	30 - 50	2.85	2 - 2.5	39 - 83	62 - 71
SEPASIL® EK 白刚玉 white fused alumina	■						■		■							3 - 45	4.00	9	97 - 99	
SILATHERM® 导热填料 thermally conductive fillers								■							■	2 - 31	3.65	5	78 - 87	25
TREFIL® 1313 硬石膏 anhydrite					■				■	■						3 - 7	3.00	4	86 - 89	19
SIPOR® PC 珠光岩 perlite										■	■		■	■	■	55 - 115		7	55 - 115	
TIKRON® 滑石粉 talc		■	■	■	■		■	■	■	■	■					3	2.80	1	92	77

本应用技术宣传册中所列的数值是按照我们所了解的情况确定并展示的。但请您理解、我们对于个别情况下的结果以及我们建议的适当性和完整性不承担责任、而且不对第三方的专利权受到侵害负责。我们愿意为您提供进一步的咨询。采用含高岭土的纸打印。

The figures documented in this brochure were collected and shown to the best of our knowledge. However, we ask for understanding that we cannot take over liability for the results in individual cases and for the suitability and completeness of our recommendations, and cannot guarantee that no third-party patent rights are restricted. We are available for further questions and consultation. Printed on paper containing kaolin.

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