TEGO® Powder Aid - Novel Evonik Additives for Powder Coatings

EVONIK Coating Additives
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Evonik Solutions for Powder Coatings

Free-flow Additives	AEROXIDE® Alu C / Alu C805; AEROSIL® 200 / 300 / R 972 TEGO® Powder Aid F05
Functional Filler	SPHERILEX® DP-0112 / -0115 / -0117
Anti-corrosion Additive	SPHERILEX® AC 45 / AC 45 HS
Adhesion Promoter	TEGO® Powder Aid C01
Degassing Additive	TEGO® Powder Aid G01

Free-flow Additives

AEROXIDE®, AEROSIL® & TEGO® Powder Aid F05

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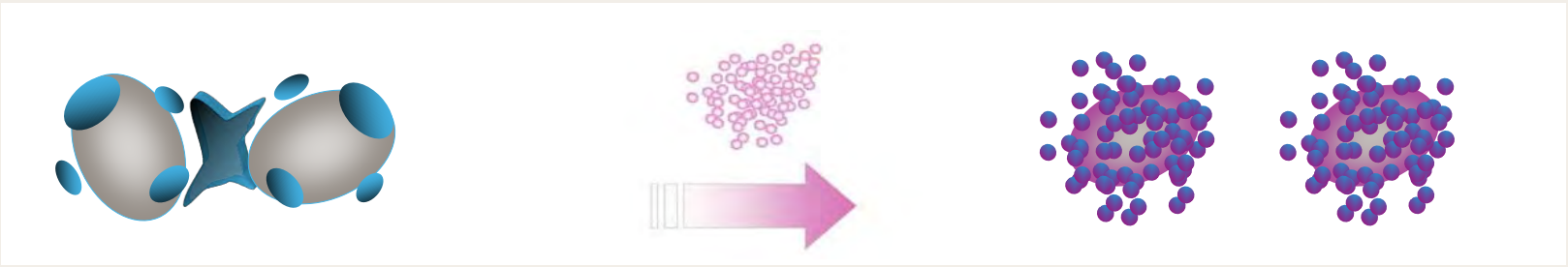
Improving Powder Free-flow and Anti-caking

Reducing Particle Cohesion

Particle Cohesion	AEROSIL® / AEROXIDE® Addition	Powder Effect



AEROXIDE® / AEROSIL® / TEGO® Powder Aid F are able to reduce interfacial forces and control moisture induced caking in powders

Interrupting Particle Interactions
by Separation

- Reduce attractive forces (Van der Waals / Electrostatic)
- Improve fluidization
- Generate “ball bearing effect”

Reducing Adhesive Forces
by Anti-humidity Effects

- Particle-liquid bridging minimized
- Prevent caking of powders
- Enable fluidization under high humidity conditions
- Hydrophobic encapsulation

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How to Choose a Suitable Free-flow Agent?

- Basic properties: moisture absorption, dispersibility, incorporate smoothly


- Powder coating flowing, fluidizing and anti-caking performance improvement


Free flow agent related performance


- Influence on surface appearance

- Influence on power particles charging and transfer efficiency

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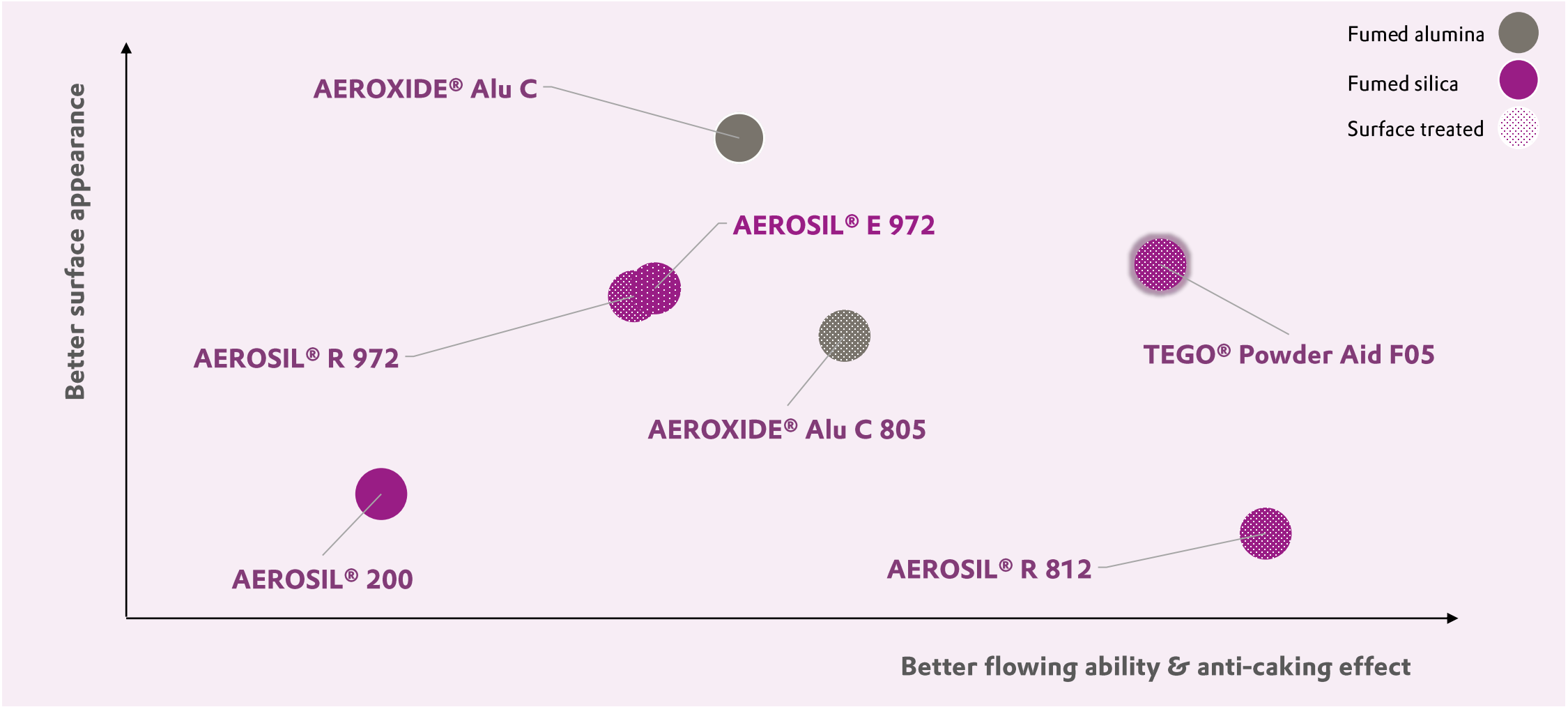
EVONIK Coating Additives –
Powder Free-flow Additives Portfolio Positioning



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Free flow of Powder Coatings

- **AEROXIDE® Alu C**
- **AEROXIDE® Alu C 805**
- **TEGO® Powder Aid F05**
- **AEROSIL® R 972**
- **AEROSIL® 200**

Before extruder

Free flow agent	**0.1 - 0.3%**
Anti-Cacking effect	**0.2 - 1.0%**

Functional Fillers

SPHERILEX® DP grades

Coating Additives

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SPHERILEX® Technology

- SPHERILEX® Technology
  - SPHERILEX® is a unique precipitated silica that is made with a patented continuous loop reactor process
  - These particles have similar low oil absorption as the current fillers used, however, the particles are very uniform with a narrow particle size distribution

New precipitated silica particle morphology

- Spherical particle shape
- Narrow particle size distribution
- Very low surface area
- Low oil absorption
- Minimal impact on viscosity

SPHERILEX® silica for coatings can improve properties of architectural coatings

- Burnish, scuff, and mar resistance
- Wet scrub resistance
- Matting

  - Effect increases with particle size

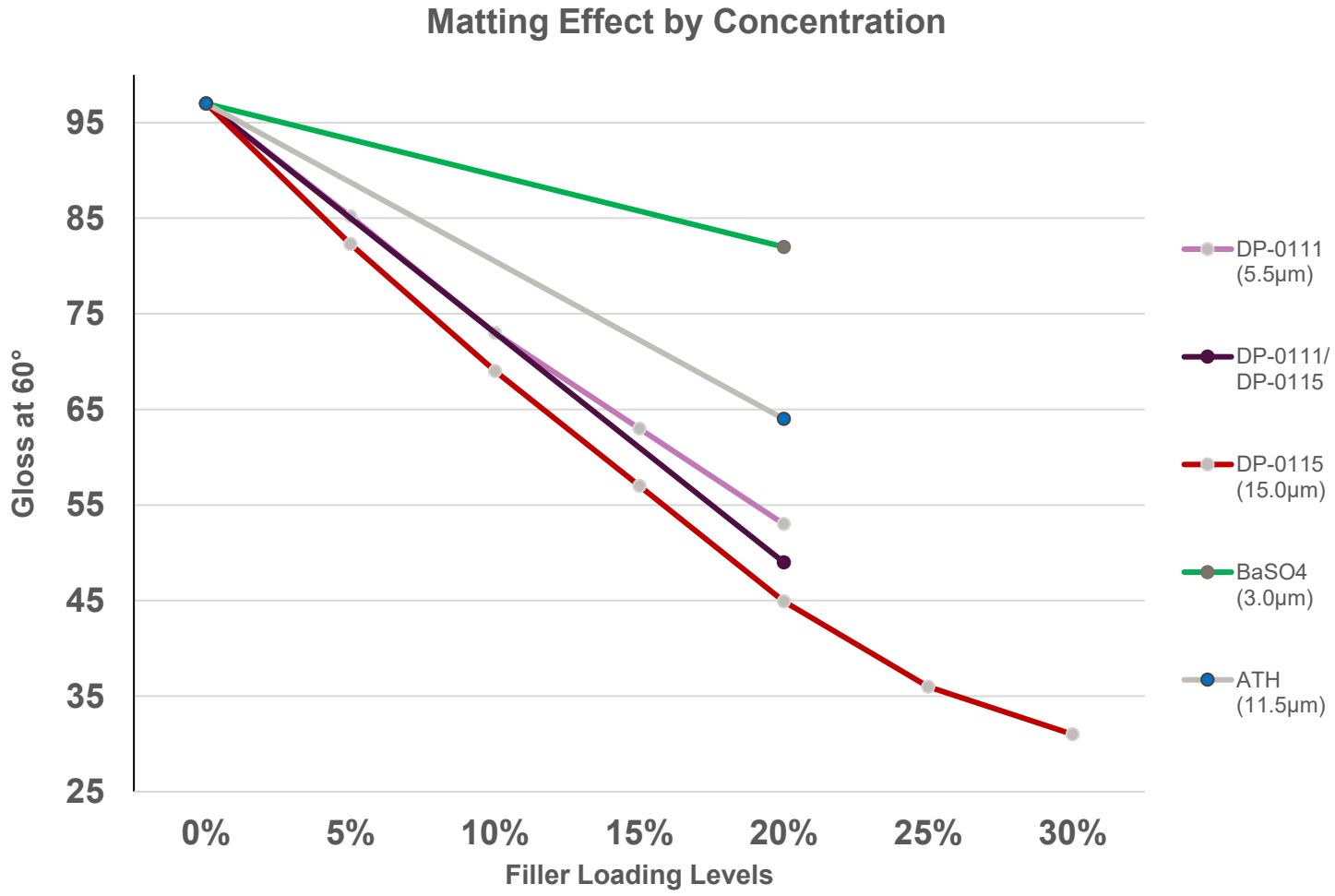
Formulation and Process Parameters (°F)

Formulation	Raw Material	20% Matting Agent
Resin	**Crylcoat® 4659-0**	368.1
Crosslinker	**Primid® XL 552**	19.4
Flow aid	**Resiflow P-67**	5.0
Degassing	**Benzoin**	2.5
Carbon black	**Black Pearls 800**	5.0
Matting Agent	***Various Fillers***	100.0
Total		500.0

This powder coating formulation is a super-durable HAA with reduced gloss that does not use any waxes

Processing Parameters		
Extruder	APV 19mm Twin Screw	500 RPM
Set Temp °F	Zone 1/2	212/212
Actual Temp °F	Zone 1/2	214/212
Extrudate Temp °F	IR gun	225-234
Torque	Depending on formula	40-60%
Mill	Strand Benchtop Mill	
Screen	[mesh]	140
Powder cure	min / °F	15 / 400

Matting Efficiency and Pill Flow



Modification	Gloss			Pill flow
	20°	60°	85°	[mm]
Control	87	**97**	103	75
5% DP-0111	52	**85**	100	69
10% DP-0111	29	**73**	92	63
15% DP-0111	16	**63**	89	60
20% DP-0111	11	**53**	86	54
20% DP-0111/DP-0115	10	**49**	77	57
5% DP-0115	48	**82**	94	70
10% DP-0115	27	**69**	84	61
15% DP-0115	15	**57**	75	64
20% DP-0115	8	**45**	68	56
25% DP-0115	6	**36**	63	55
30% DP-0115	4	**31**	59	58
20% $BaSO_4$	47	**82**	99	69
5% DP-0115/15% $BaSO_4$	30	**72**	93	64
20% ATH	20	**64**	84	66
5% DP-0115/15% ATH	17	**61**	81	62

*Pill flow [mm] uses 1 g sample @400°F.

This is an indirect measurement of melted powder coating viscosity. Higher numbers in mm (distance) means melted viscosity is lower. Lower numbers in RED means higher melt viscosity.

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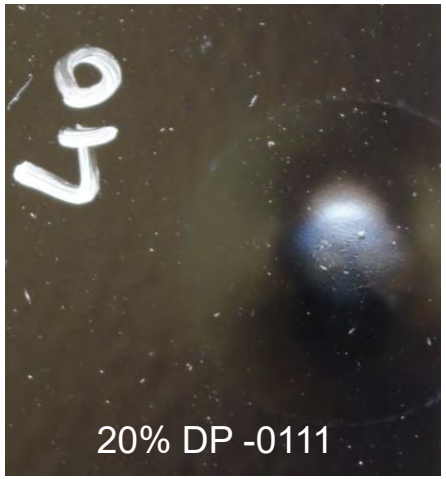
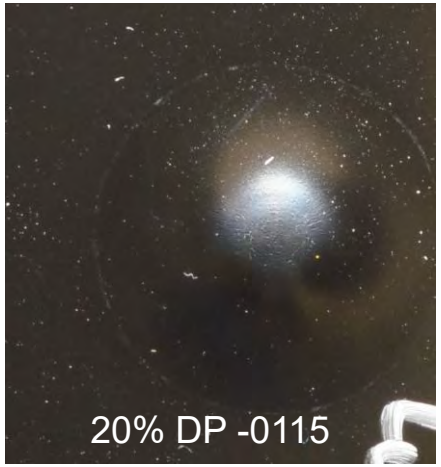
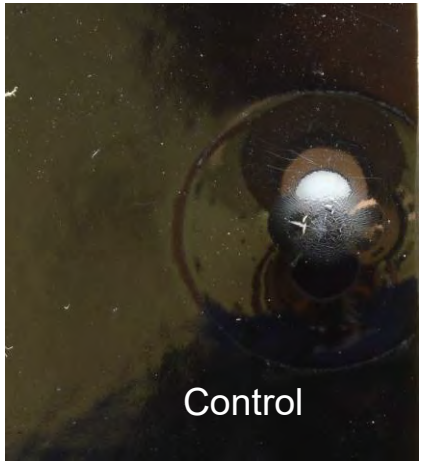
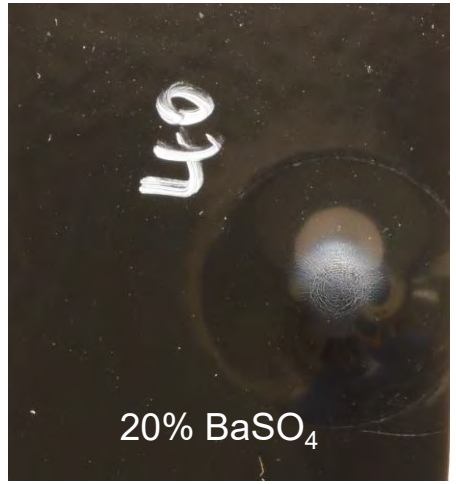
Reverse Impact Test

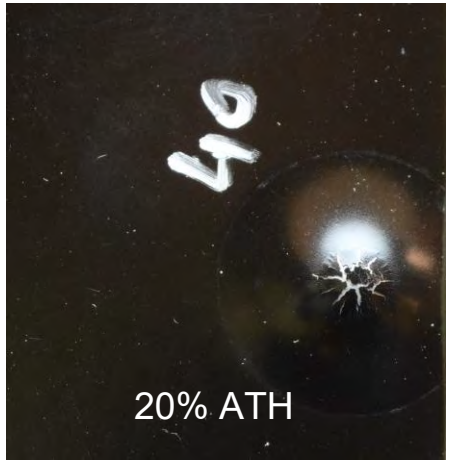
Modification	Impact test 40 in-lb (reverse) @ 3.0 mils
Control	some cracking
5% SPHERILEX® DP-0111	some cracking
10% SPHERILEX® DP-0111	no cracking
15% SPHERILEX® DP-0111	no cracking
20% SPHERILEX® DP-0111	minor cracking
5% SPHERILEX® DP-0115	minor cracking
10% SPHERILEX® DP-0115	no cracking
15% SPHERILEX® DP-0115	no cracking
20% SPHERILEX® DP-0115	minor cracking
20% SPHERILEX® DP-0111/DP-0115	minor cracking
20% $BaSO_4$	some cracking
5% SPHERILEX® DP-0115/15% $BaSO_4$	some cracking
20% ATH	severe cracking
5% SPHERILEX® DP-0115/15% ATH	severe cracking
Impact test rating scale: no > minor > some > severe	











Substrate: CRS B1000

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SPHERILEX® DP - Conclusion

- Improved matting efficiency versus conventional fillers
- SPHERILEX® DP grades show positive effect on mechanical properties e.g. hardness or flexibility
- No blooming, such as when using wax to reduce gloss
- SPHERILEX® DP-0115 is easily dispersed in powder coatings by post-adding process; It's suitable for gloss adjustment in manufacturing

Anti-corrosion Additives

SPHERILEX® AC 45 &

SPHERILEX® AC 45 HS

EVONIK Coating Additives

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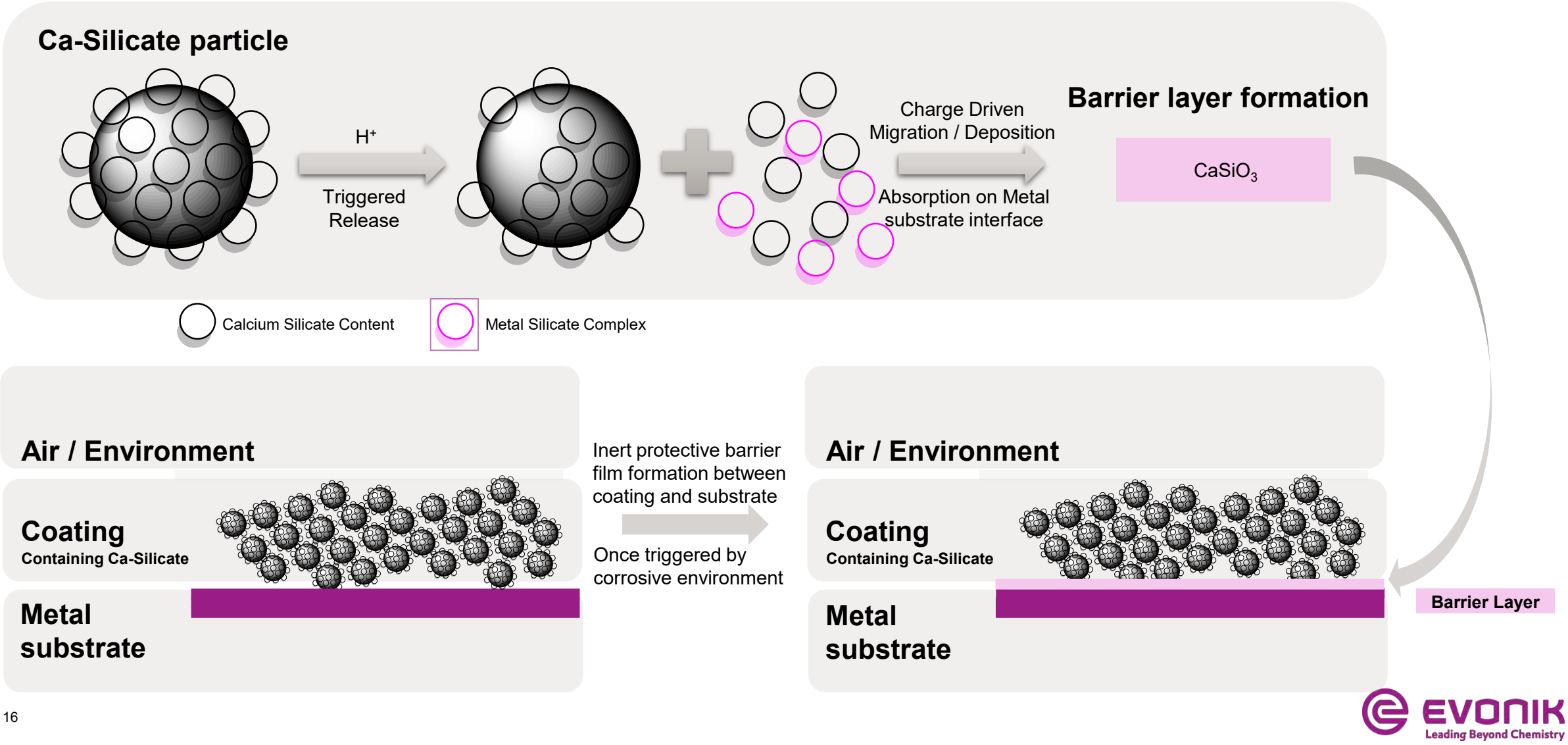
New Calcium Silicate Additive - Available in 2 Versions

Two types are available, with slightly lower and slightly higher oil absorption

Technical specification	SPHERILEX® AC 45	SPHERILEX® AC 45 HS
Calcium oxide content (%)	6.5 - 7.5	6.5 - 7.5
% Loss on drying (105°C for 2h)	< 5	< 7
pH (5% in water)	9.0 - 10.5	9.0 - 10.5
Conductivity (µS/cm)	< 350	< 350
APS d_{50} (µm)	4.0 - 6.0	4.0 - 5.5
Density (kg/m³)	360	420
BET multipoint (m2/g)	**55 - 85**	**80 - 110**
Oil absorption (cc/100g)	**80 - 110**	**110 - 140**
ISO brightness	> 90	> 90

Innovative Calcium Silicate Technology

Ion exchange mechanism



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Test Formulation in Epoxy / Polyester Powder Coating

Chemical system: Epoxy / Polyester

Color: Black

Component	Blank	SPHERILEX® AC 45 HS
NPES 903H	35.0	35.0
Uralac P5127	35.0	35.0
RESIFLOW P-67	1.0	1.0
BENZOIN	0.5	0.5
FW 200 Powder	0.8	0.8
HH-PBS ($BaSO_4$)	27.5	22.5
SPHERILEX® AC 45 HS	-	**5**
AEROXIDE® Alu C	0.2	0.2
Total	100	100

Test Result in Epoxy/polyester Powder Coating

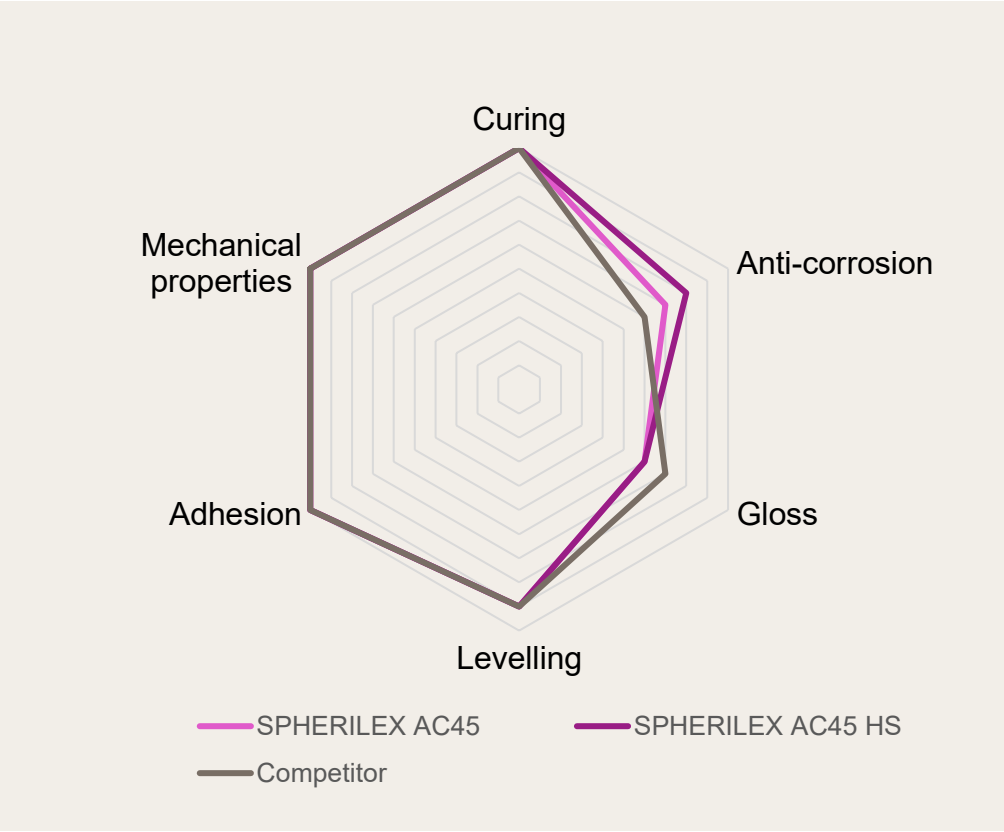
Neutral salt spray test— 168h

On sand blasted container substrate, SPHERILEX® AC 45 HS can improve anti-corrosion performance.

Test Items	Sand blasted substrate	
	Blank	5% SPHERILEX® AC 45 HS
Average single delamination width	3.3 mm	1.8 mm
Max single delamination width	5.0 mm	3.0 mm
Test photos		

Summary

- **SPHERILEX® AC 45 and AC 45 HS** can significantly improve anti-corrosion performance on sandblasted substrate, but also have slight improvement on iron phosphate steel, so SPHERILEX® AC 45 and AC 45 HS **are recommended to use on sandblasted substrate and container substrate**;
- **SPHERILEX® AC 45 and AC 45 HS** have better anti-corrosion performance than competitor;
- **SPHERILEX® AC 45 and AC 45 HS** have no obvious influence on levelling and mechanical performance



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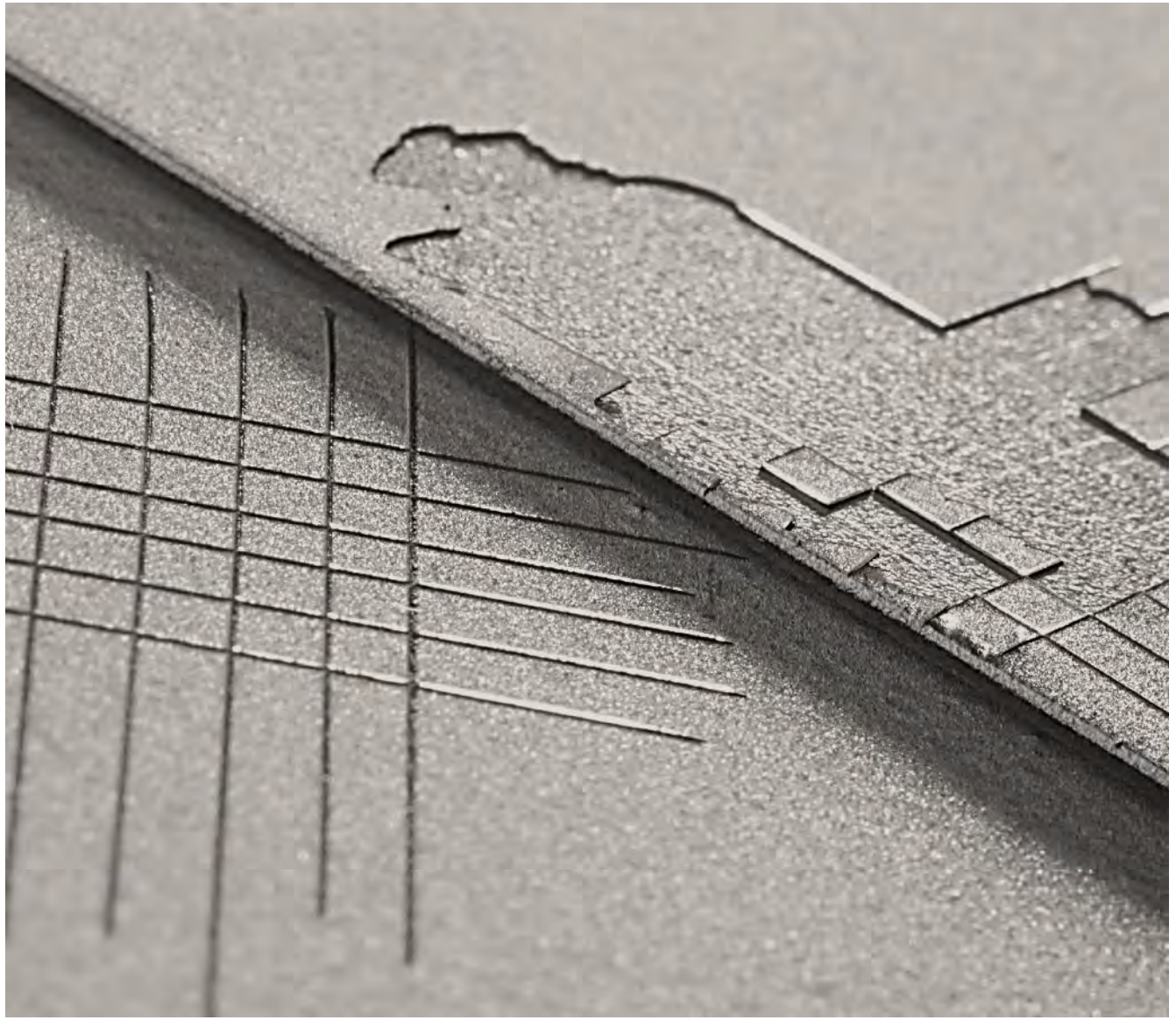
Adhesion Promoter

TEGO® Powder Aid C01

EVONIK Coating Additives



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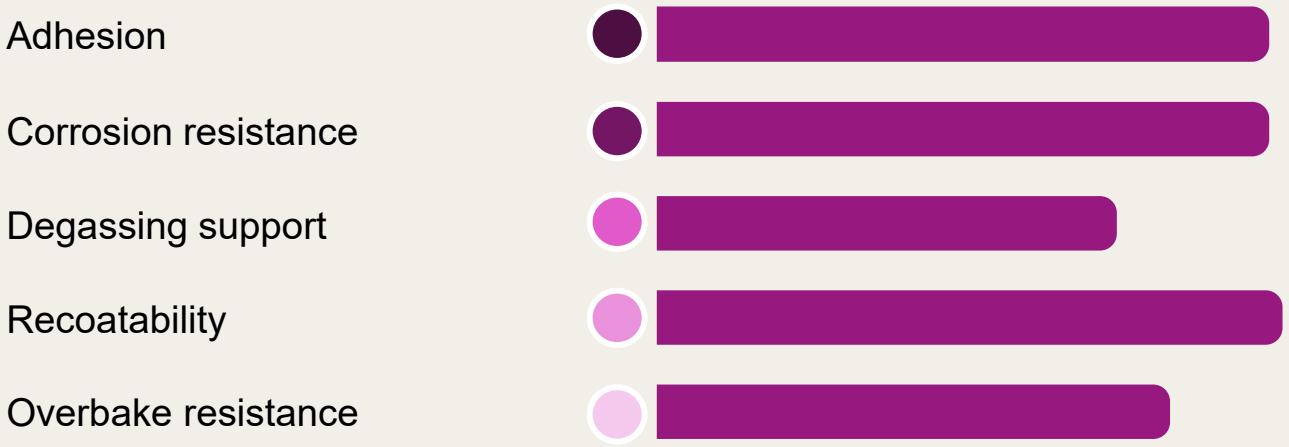
TEGO® Powder Aid C01

Corrosion Resistance + Adhesion Promotion

Polyester modified polymer, polyester based

- 100 % active matter content
- High compatibility
- No significant influence on rheology profile
- Developed especially for powder coatings



Technical information

Delivery form	**granulated**
Active matter content	**100 %**
Processing temperature	**90 - 120 °C**

Recommended addition level

1.0 % up to 3.0 % calculated on total formulation

Processing Instructions

Incorporation with the raw material pre-mix and processing through extrusion.

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Improved Corrosion Resistance

Powder coating based on polyester resin with a ß-HAA crosslinker

TEGO® Powder Aid C01 optimizes corrosion protection and adhesion properties of the coating

Test formulation, blank sample

+2 % TEGO® Powder Aid C01

Test formulation – Blank sample	
Polyester resin	61.8
ß-HAA crosslinker	3.2
Degassing agent	0.3
Flow / levelling agent	1.0
Pigment TiO_2	22.5
Filler	11.2
Total	**100.0**
AEROXIDE® Alu C	0.3

Polyester resin	:	**ß-HAA crosslinker**
95	:	5

- Additive is included in the premix and extruded
- Cold rolled steel panels (untreated)
- Single layer, DFT ~ 80-85 µm
- Curing conditions: 15’ 180 °C
- 240 hours salt spray test

TEGO® Powder Aid C01 vs. Benchmark

Powder coating based on polyester resin with a ß-HAA crosslinker

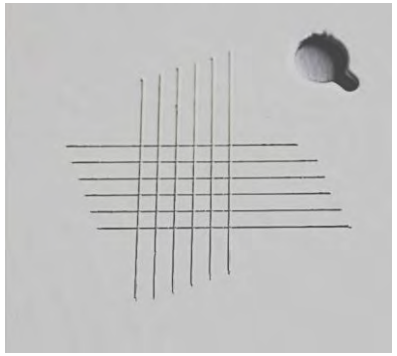
The effect on gloss when using TEGO® Powder Aid C01 is better than with a silica-carrier based adhesion promoting additive (competitor)

Excellent adhesion on steel and aluminum

	Blank	3 % benchmark (silica-carrier based)	3 % TEGO® Powder Aid C01
Gloss value [20°]	65	46	**63**
Gloss value [60°]	92	84	**91**
Cross cut on steel	GT 0	GT 0	**GT 0**
Cross cut on aluminum	GT 0	GT 2	**GT 0**
Cupping test / flexibility [mm]	1.5	1.2	**2.6**

3 % benchmark silica-carrier based

3 % TEGO® Powder Aid C01



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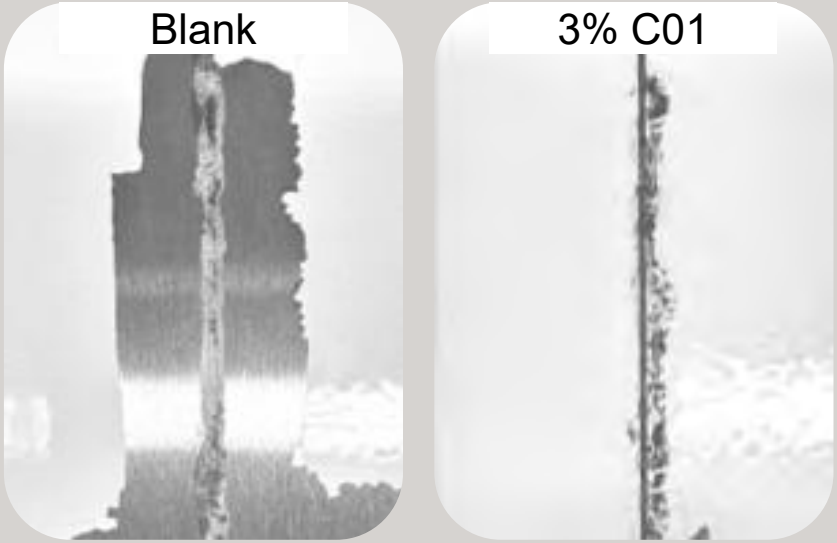
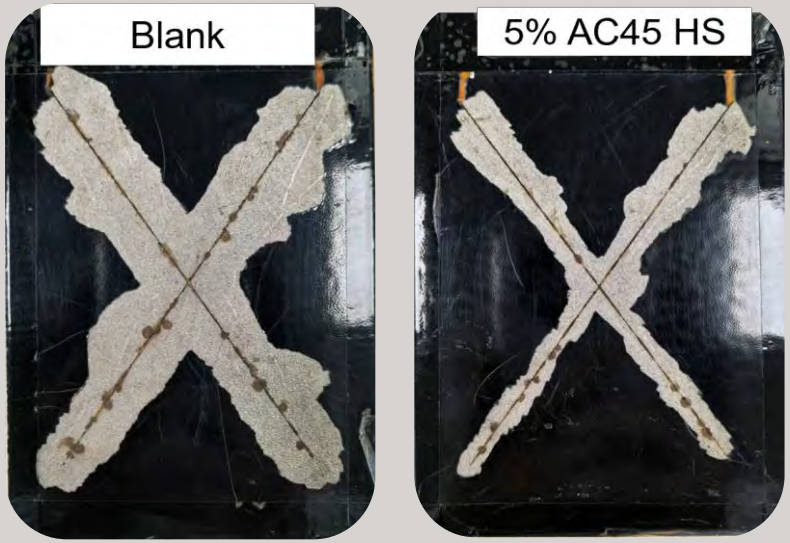
Additives for Coating Protection – Adhesion & Corrosion



Synergistic effects



TEGO® Powder Aid C01

Adhesion promoting additive on organic carrier material

SPHERILEX® AC 45 / AC45 HS

Ion-exchange Ca-Sil spherical anti-corrosion pigment

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TEGO® Powder Aid C01 & SPHERILEX® AC 45

Hybrid System for Corrosion Protection

EVONIK Coating Additives

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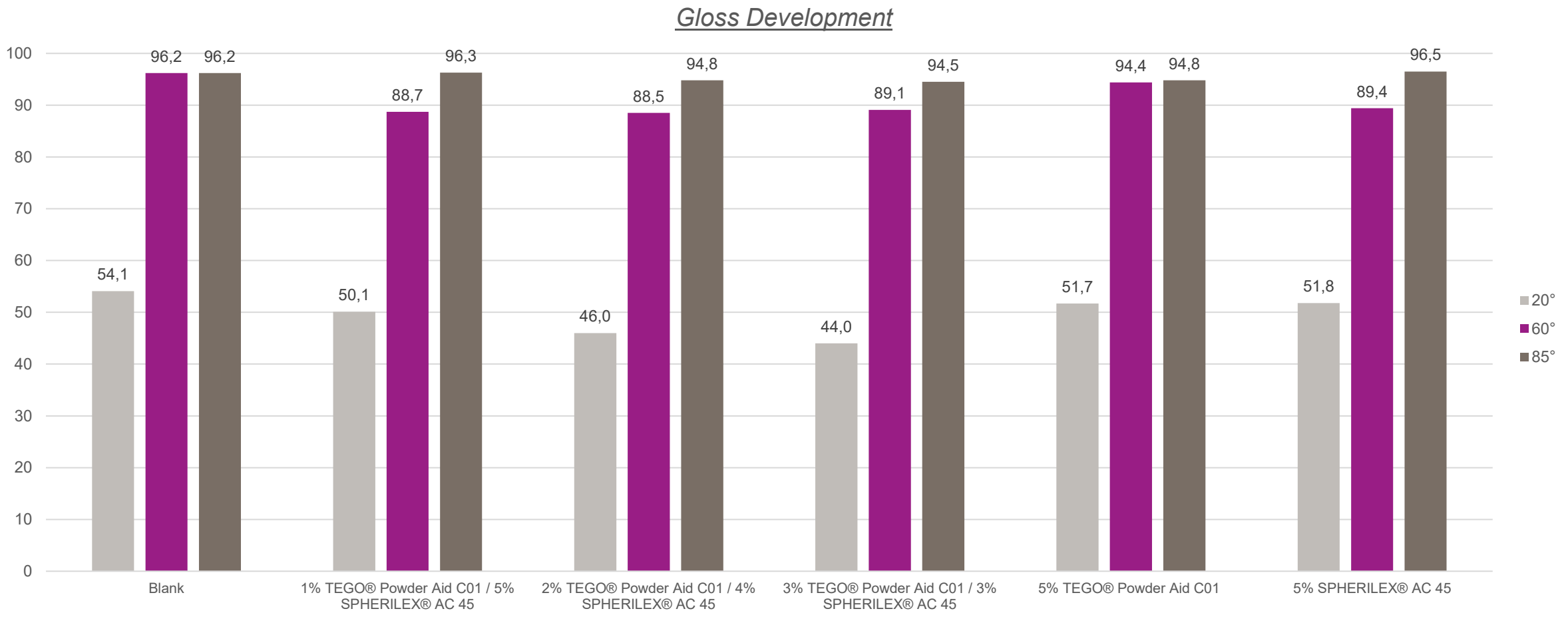
Polyester Epoxy Hybrid system

Crylcoat® 1770-0 / D.E.R.™ 663 UE (70/30)

Chemistry	Product	Blank	1% TEGO® Powder Aid C01 / 5% SPHERILEX® AC 45	2% TEGO® Powder Aid C01 / 4% SPHERILEX® AC 45	3% TEGO® Powder Aid C01 / 3% SPHERILEX® AC 45	5% TEGO® Powder Aid C01	5% SPHERILEX® AC 45
Polyester resin	Crylcoat® 1770-0	45,9	45,2	44,5	43,8	42,4	45,9
Epoxy resin	D.E.R.™ 663 UE	19,7	19,4	19,1	18,8	18,2	19,7
Flow/levelling	Resiflow® P-67	1,0	1,0	1,0	1,0	1,0	1,0
Adhesion	***TEGO® Powder Aid C01***	---	**1,0**	**2,0**	**3,0**	**5,0**	---
Corrosion Add.	***SPHERILEX® AC 45***	---	**5,0**	**4,0**	**3,0**	---	**5,0**
Pigment	TiO2	22,0	22,0	22,0	22,0	22,0	22,0
Filler	BaSO4	11,4	6,4	7,4	8,4	11,4	6,4
∑		**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**

- Twin screw extruder, heat zones up to 110°C, torque ~40% at 400rpm
- Curing conditions: 15 minutes at 180°C
- Substrate: cold-rolled steel, dull matte finish (R46/Q-Lab)
- DFT ~ 75-80µm

Gloss – Hybrid System



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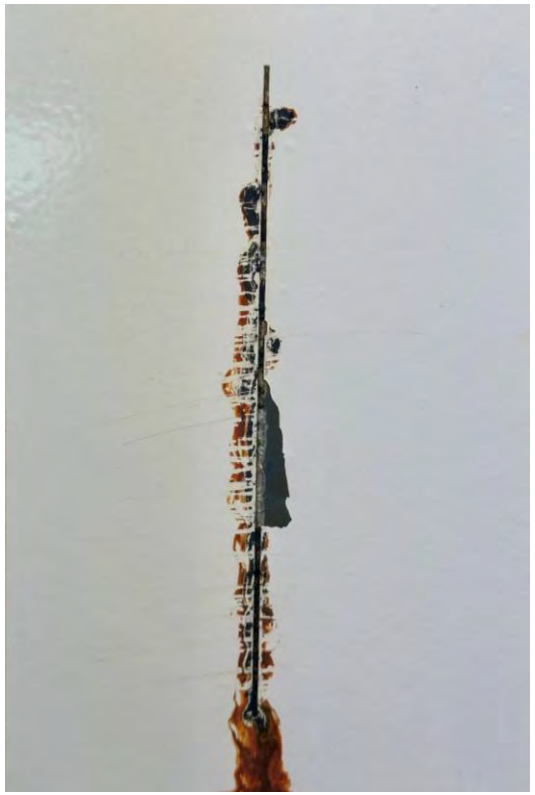
After 860h of Natural Salt Spray Test

Blank

1% TEGO® Powder Aid C01
5% SPHERILEX® AC 45

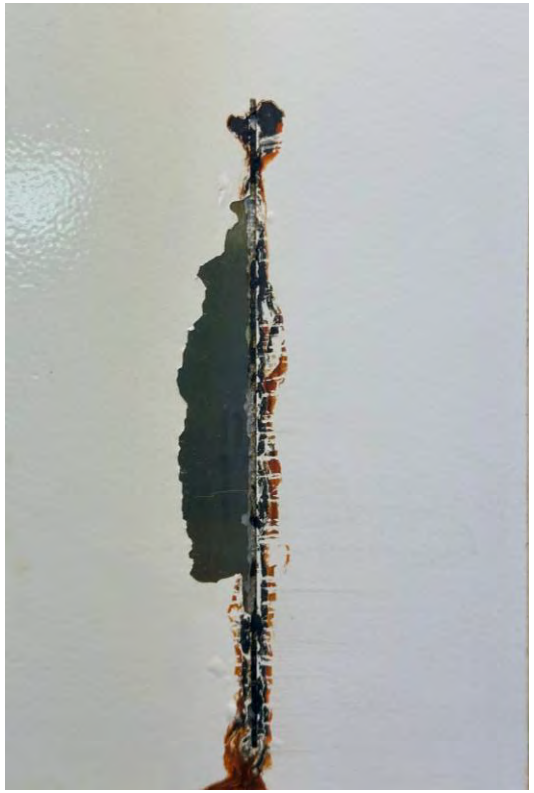


2% TEGO® Powder Aid C01
4% SPHERILEX® AC 45

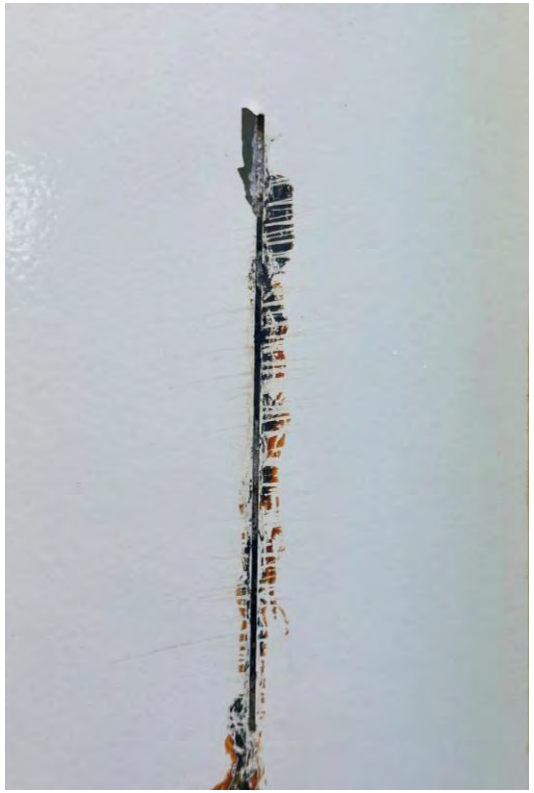
3% TEGO® Powder Aid C01
3% SPHERILEX® AC 45

After 860h of Natural Salt Spray

Blank



5% TEGO® Powder Aid C01



5% SPHERILEX® AC 45

After 860h of Neutral Salt Spray

Blank

2 - 3% **TEGO® Powder Aid C01**

3 - 4% **SPHERILEX® AC 45**

Additives for powder coatings formulations

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Highlighting technical information

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Top product recommendations for various application fields

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AEROXIDE® products

SPHERILEX® products

TEGO® Powder Aid products

ARTICLES
Coatings & Adhesives Journal

TEGO® Powder Aid C01

TEGO® Powder Aid F05

SPHERILEX® DP-0117

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