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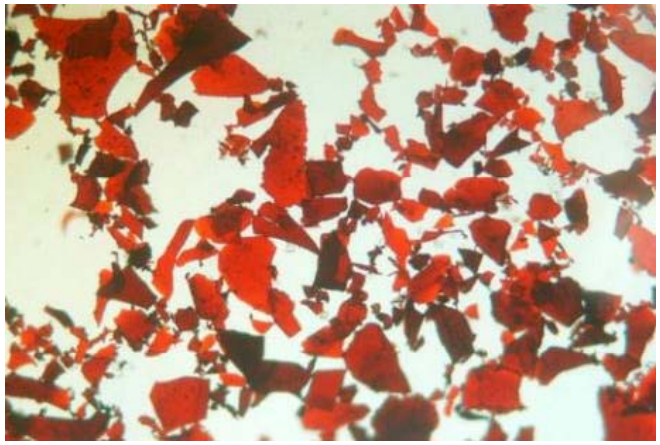
Micaceous Iron Oxides as functional mineral in coatings: The potential of micronized grades and their new applications

ECC 2013, Nuremberg / Germany

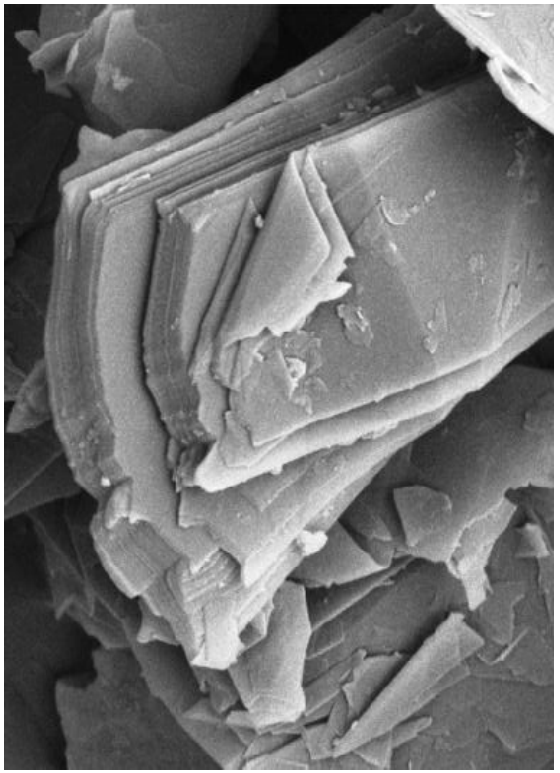
OUTLINE

- Industrial Minerals – Fillers vs. Functional Minerals
- Possible functions
- MIO`s: Quality parameter / basic properties – functions
- Standard Grade MIO´s: applications - limitations
- Micronized MIO´s: Improved functionality
  - Test setup
  - Results
- Novel applications
- Conclusions

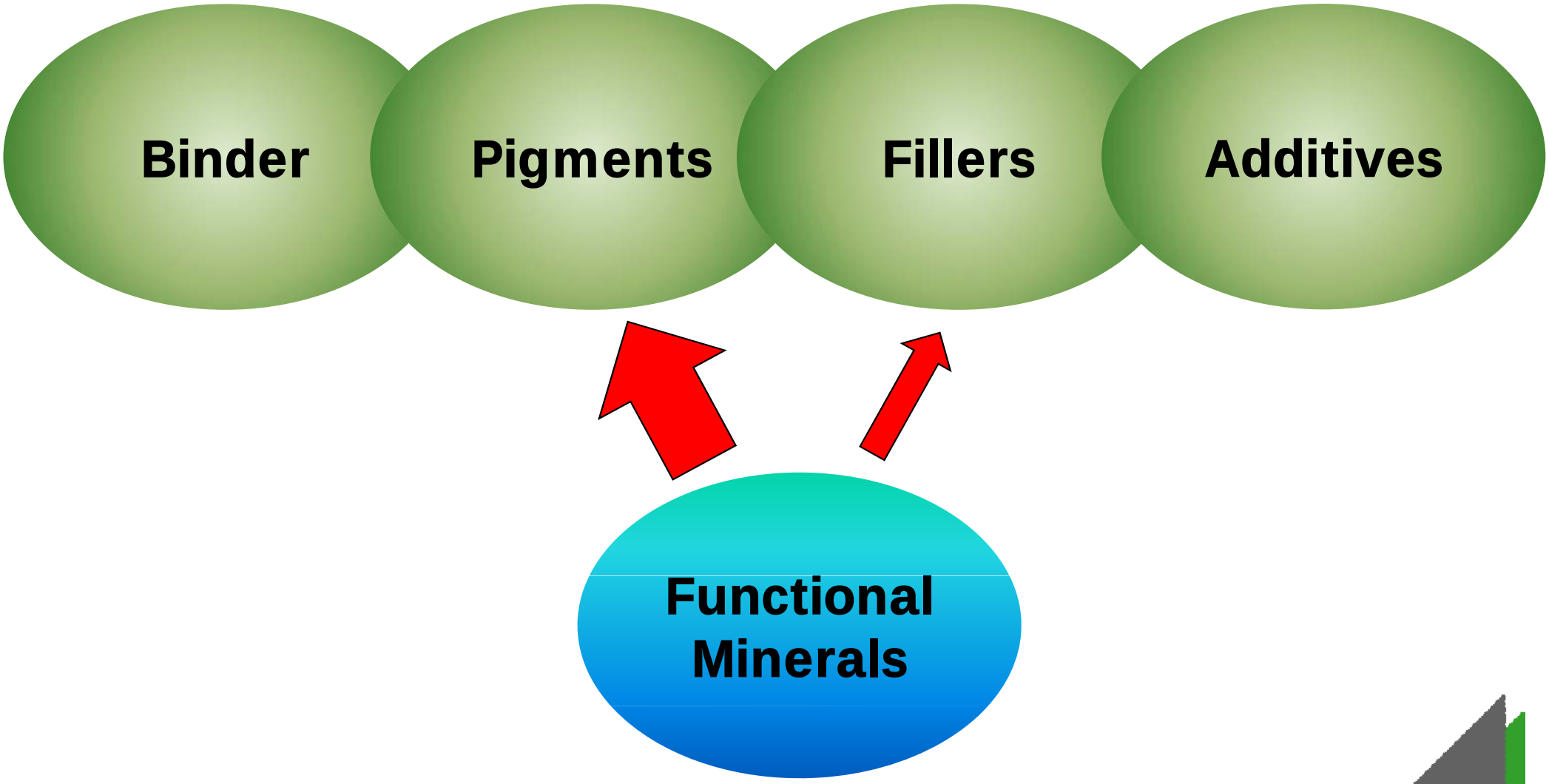


Functional Minerals: Definition

- Group of Industrial Minerals
- Natural mineral
- Distinctive function in the application
- No filler!
- Adaption of physical and chemical properties
  - Improvement of mechanical properties
  - Optical properties (UV absorption, etc.)
  - Corrosion protection



Coatings Raw Material Classification

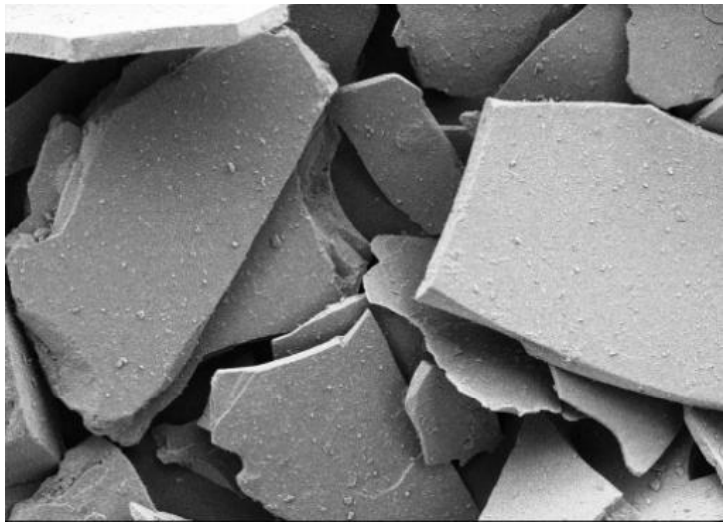


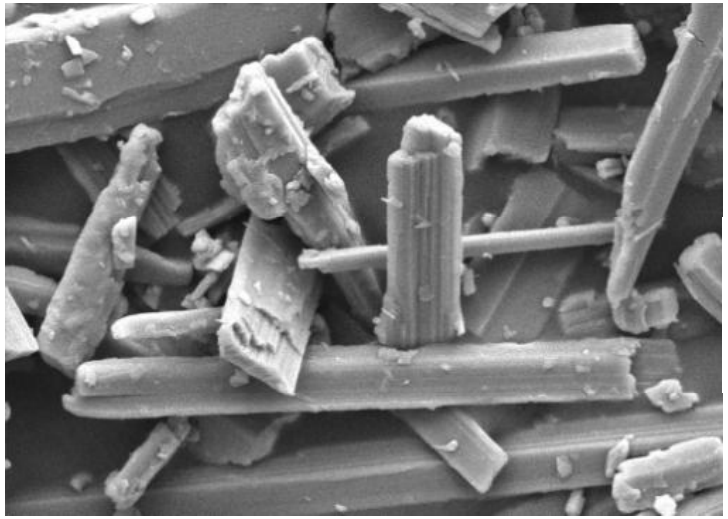
Particle Shape / Surface

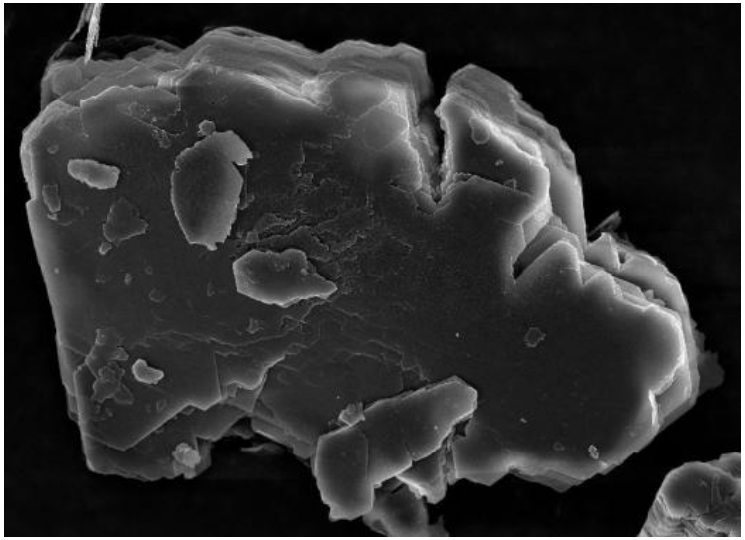
- Lamellar
- Acicular

} Aspect Ratio

- Microcracks (oil absorption)
- Surface damages

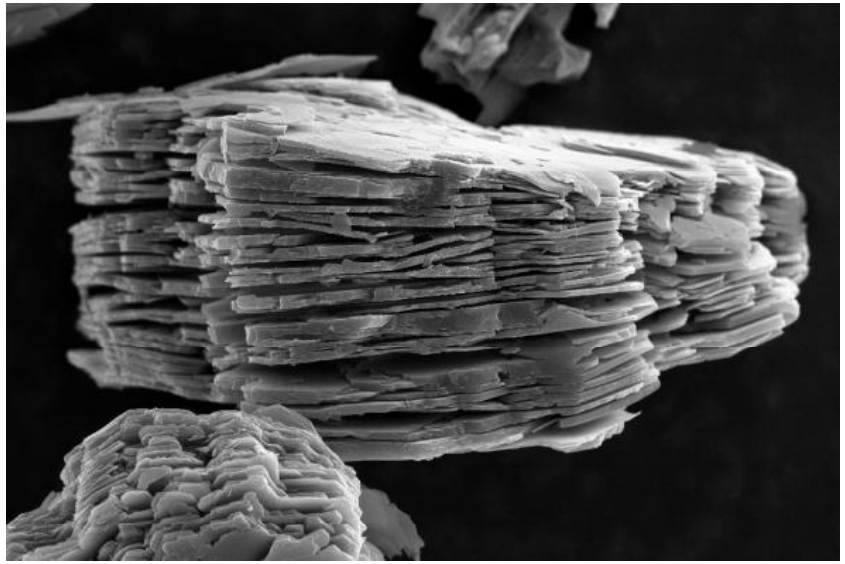


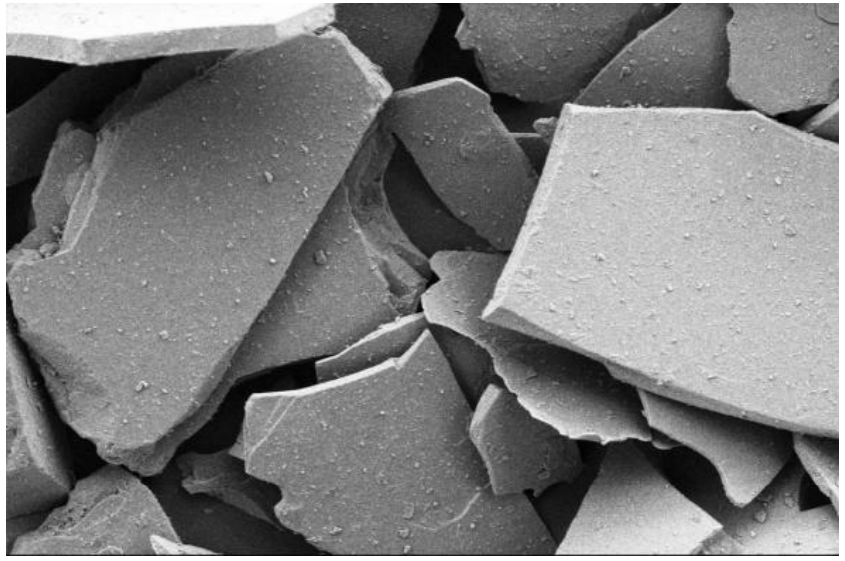




Mineralogy

- Chrystal lattice
- 2D – stability
- 3D – stability
- Chemical resistance

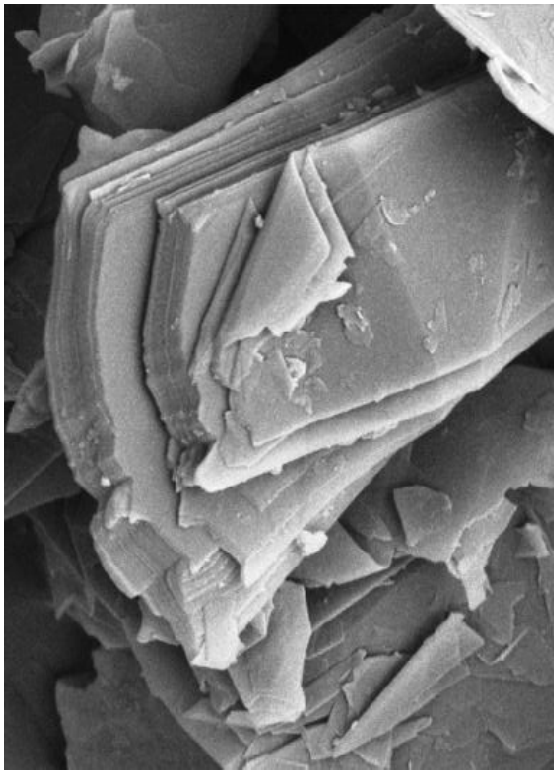




Influence on corrosion resistance

Examples

- Mica (Muscovite, Phlogopite)
- Wollastonite
- Graphite
- Talc (close to fillers)
- Huntite (flame retardant)
- Micaceous Iron Oxide (MIO)



MIO and KMI

- Austrian based company
- Family owned since 1851
- World market leader in MIO
- Export rate >95%, >80 countries
- Focus on grade A quality
- Several raw material recourses, secured supply for grade A qualities
- Experts in micronization and delamination
- Acknowledged leader in R&D of MIO products

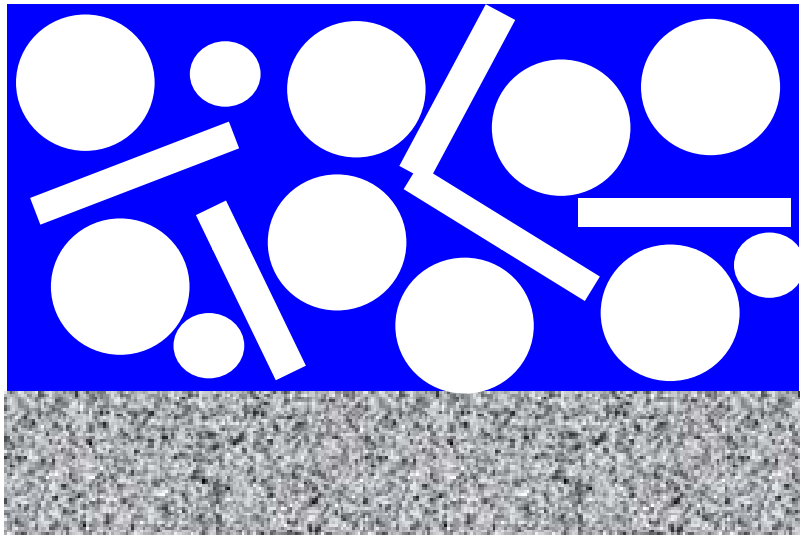
MIO- Basic Properties

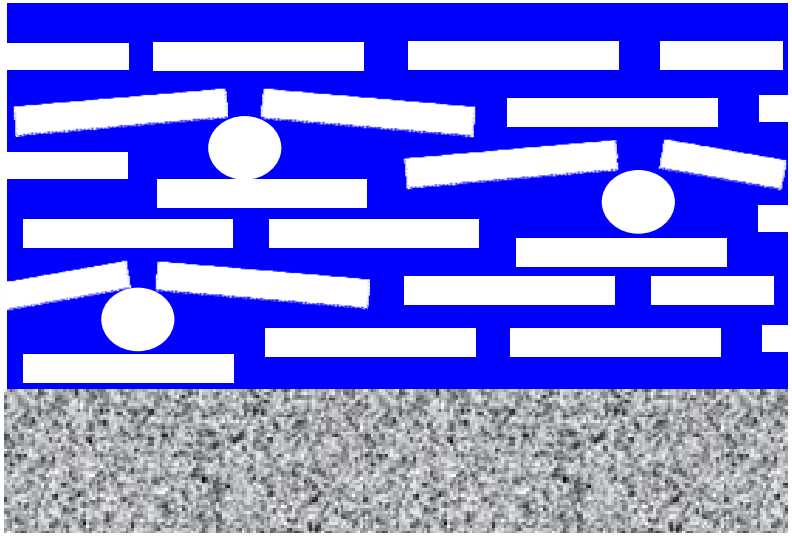
- Functional Mineral
- Green Product
- Mineralogy: Hematite
- Chem. formula: Fe_2O_3 (iron-III-oxide)
- Particle shape: platy
- Color: dark grey to reddish brown, metallic
- Density: 4,8 g/cm³
- Hardness: 6,0–6,5 Mohs

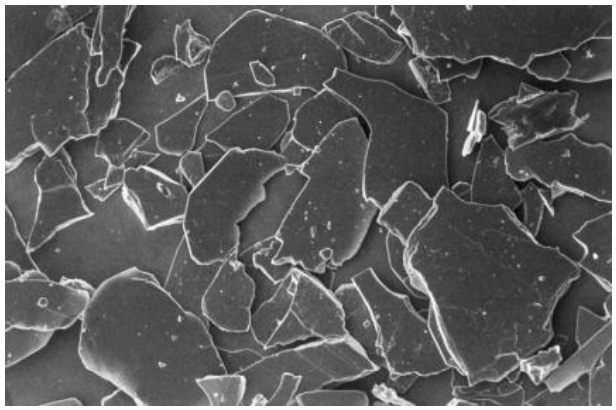
MIO- Standards

- ISO 10601
- ASTM D 5532
- National regulatory (e.g.: TB/TL – KOR; Germany)
- Content of lamellar particles (min. 65%)
- Constant Color
- Fe_2O_3 content

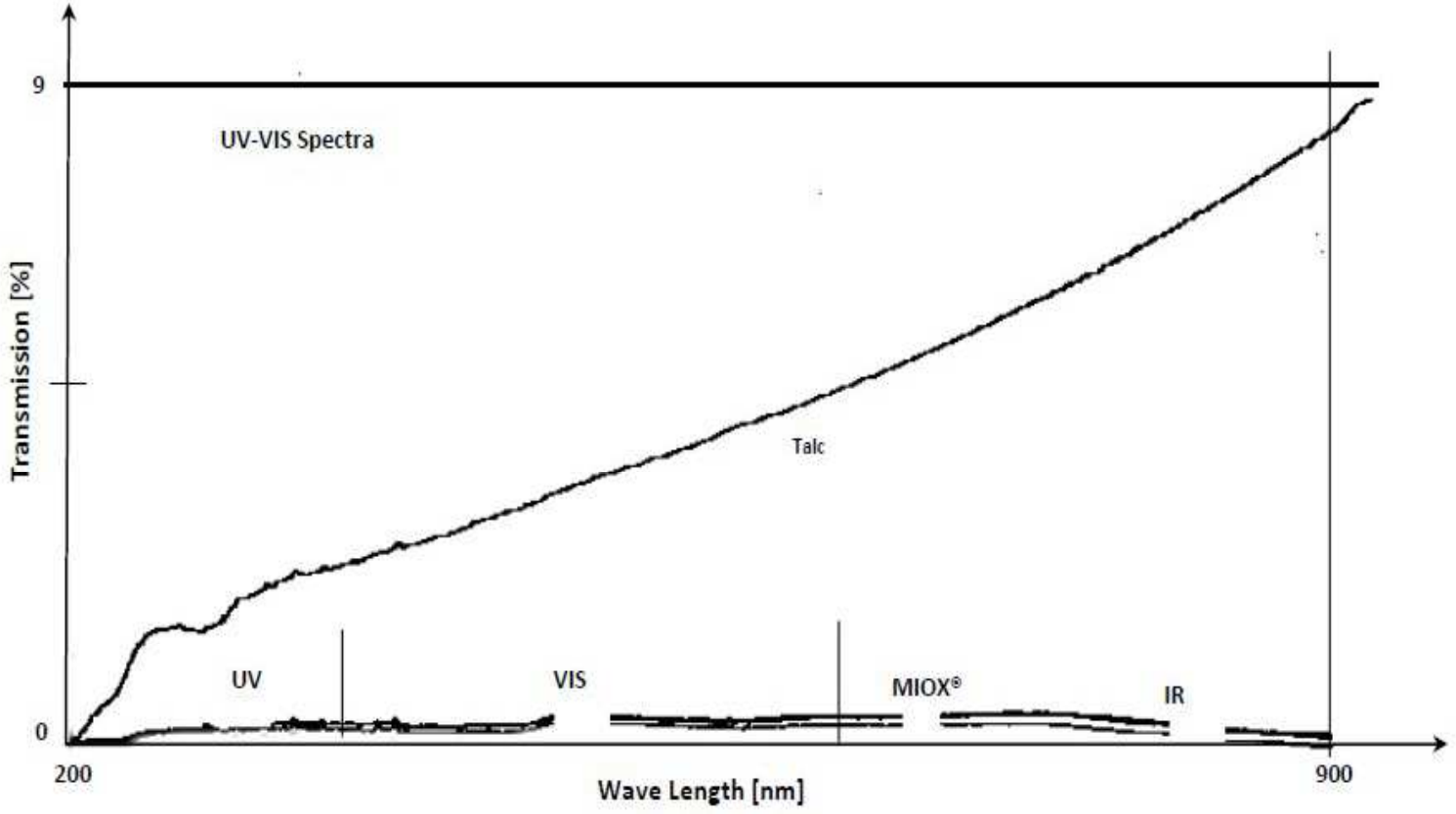
Barrier effect of MIO in Coatings







Shield effect of MIO in Coatings



Exceptional UV/VIS/IR Absorption!

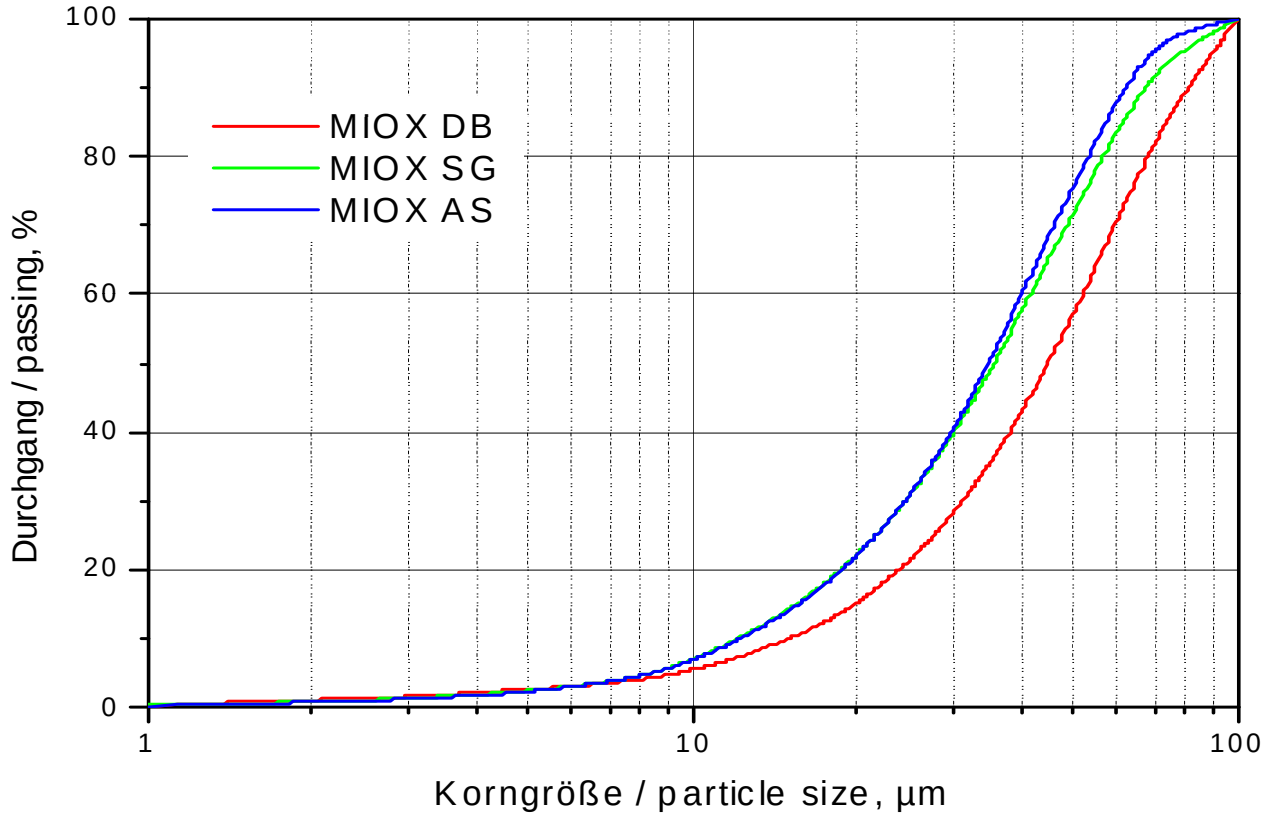
Improvement of Adhesion

Talc/Dolomite
3 MPa 100% A/B

MIO Standard
2,7 MPa 20% A/B,
80% Y

MIO Micronized
2,8 MPa 100% B/Y

MIO Standard Grades



- Top Cut 100 µm
- 90% finer than 63 µm

Application of Standard Grades

- Protective coatings
  - Heavy duty anti corrosive coatings
- Decorative metal protection

New Micronized Grades

- Application of standard grades is limited due to particle size distribution
- Technical challenge: keeping the functionality
  - Aspect ratio
  - Steep PSD
  - Color

→ Special grinding and classifying technology

MIOX MICRO and SUBMICRO – series, properties

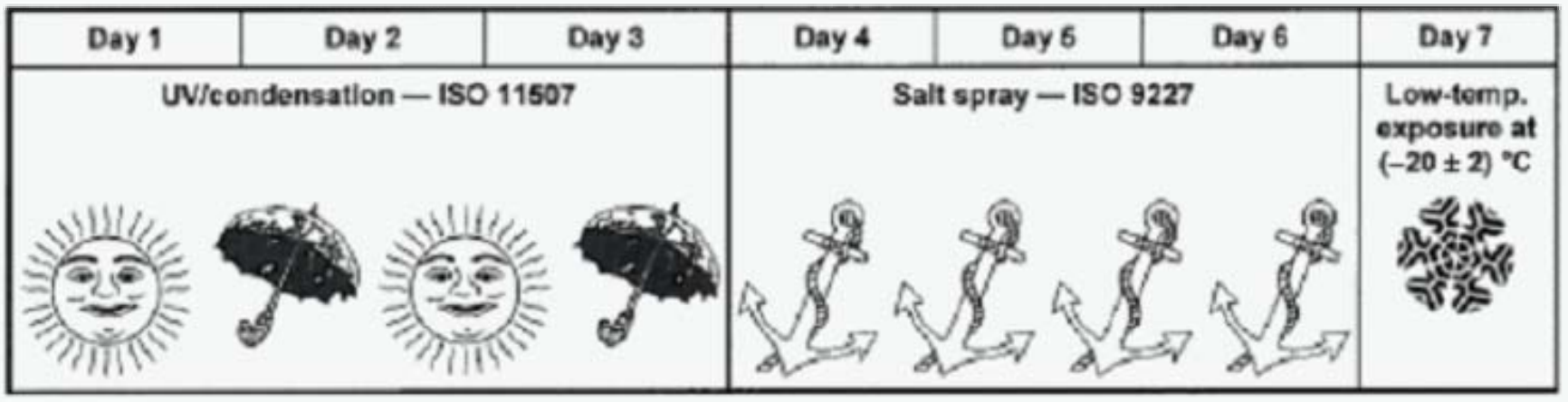
	MICRO 30	MICRO 40	MICRO 50
Shape	lamellar		
Color	grey / metallic		
d_{98}	30 µm	40 µm	50 µm

	MICRO 20	MICRO 15	MICRO 10
Shape	lamellar		
Color	red		
d_{98}	20 µm	15 µm	10 µm

	Submicro 5	Submicro 2,5
Shape	lamellar	
Color	red	
d_{98}	5 µm	2,5 µm

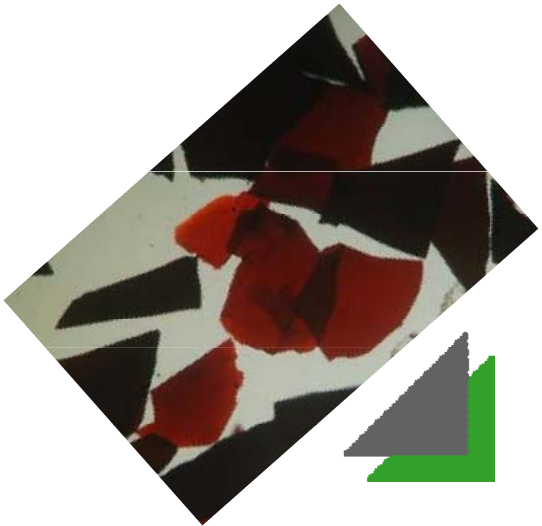
Anti corrosive performance Test Methods

- Salt spray test acc. to ISO 9227 just for barrier properties (primer coatings)
- Cyclic weathering test acc. to ISO 20340 for anti corrosive properties (coating systems)
- UV / condensation / salt spray / temperature



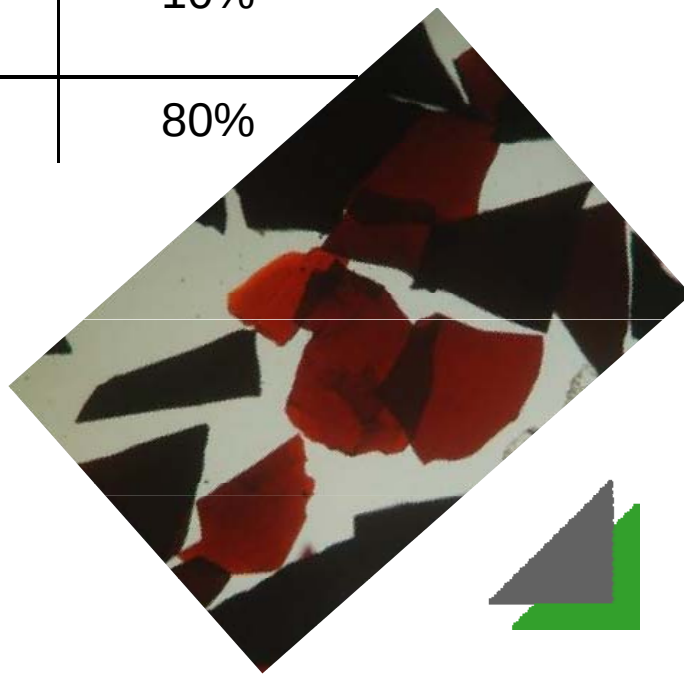
General Test Setup, systems and formulations

- 2 and 3 layer systems, dft per coat between 50 and 100 microns
- Substrate: steel previous cleaned, sand blasted and galvanized
- 2k EP Zn-Phosphate primer, 2k EP MIO, optional 2k PU topcoat; all solvent borne
- Standard formulations acc. to DB-TL 918300

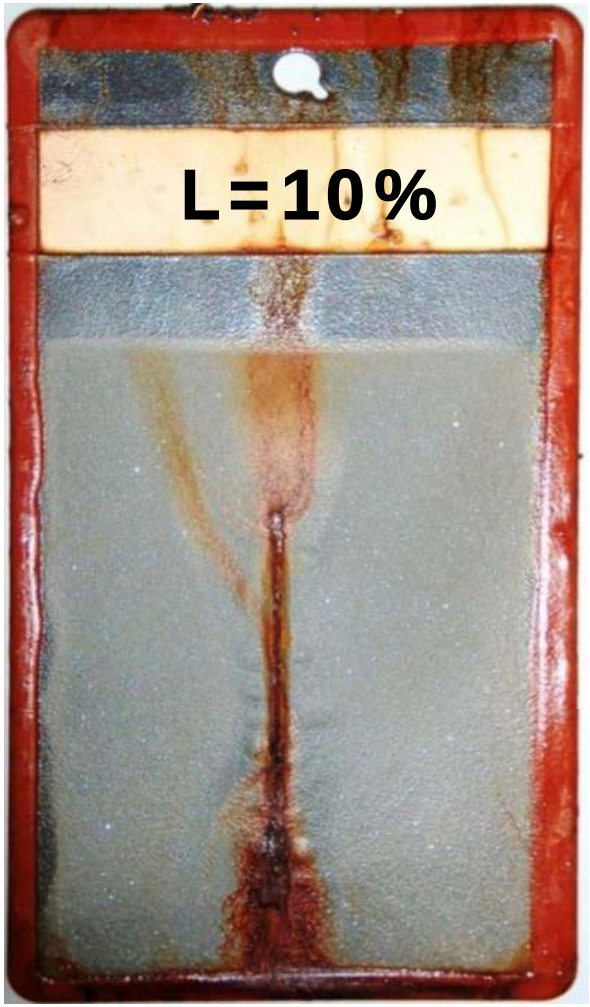


General Test Setup, MIO´s

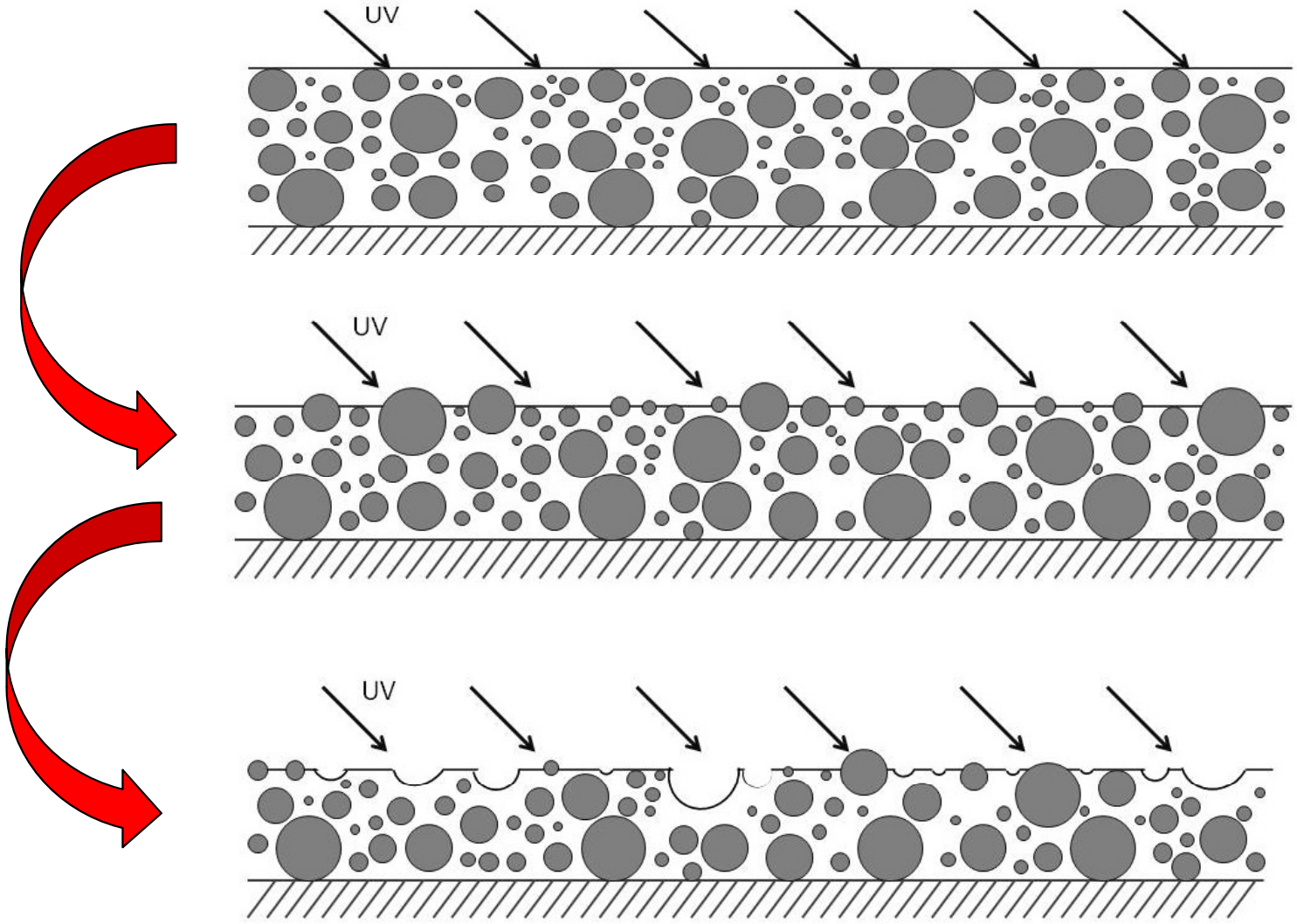
Sample identification	Brand name	Fineness	Fe_2O_3 content	Content of lamellar particles
MIO 1	MIOX® SG	max 0,1% >105µm	>85%	80%
MIO 2	experimental product	max 0,1% >105µm	>85%	10%
MIO 3	MIOX® Micro 30	d_{98} = 30µm	>85%	80%



Influence of lamellarity on anti corrosive performance



Model of Weathering Influence



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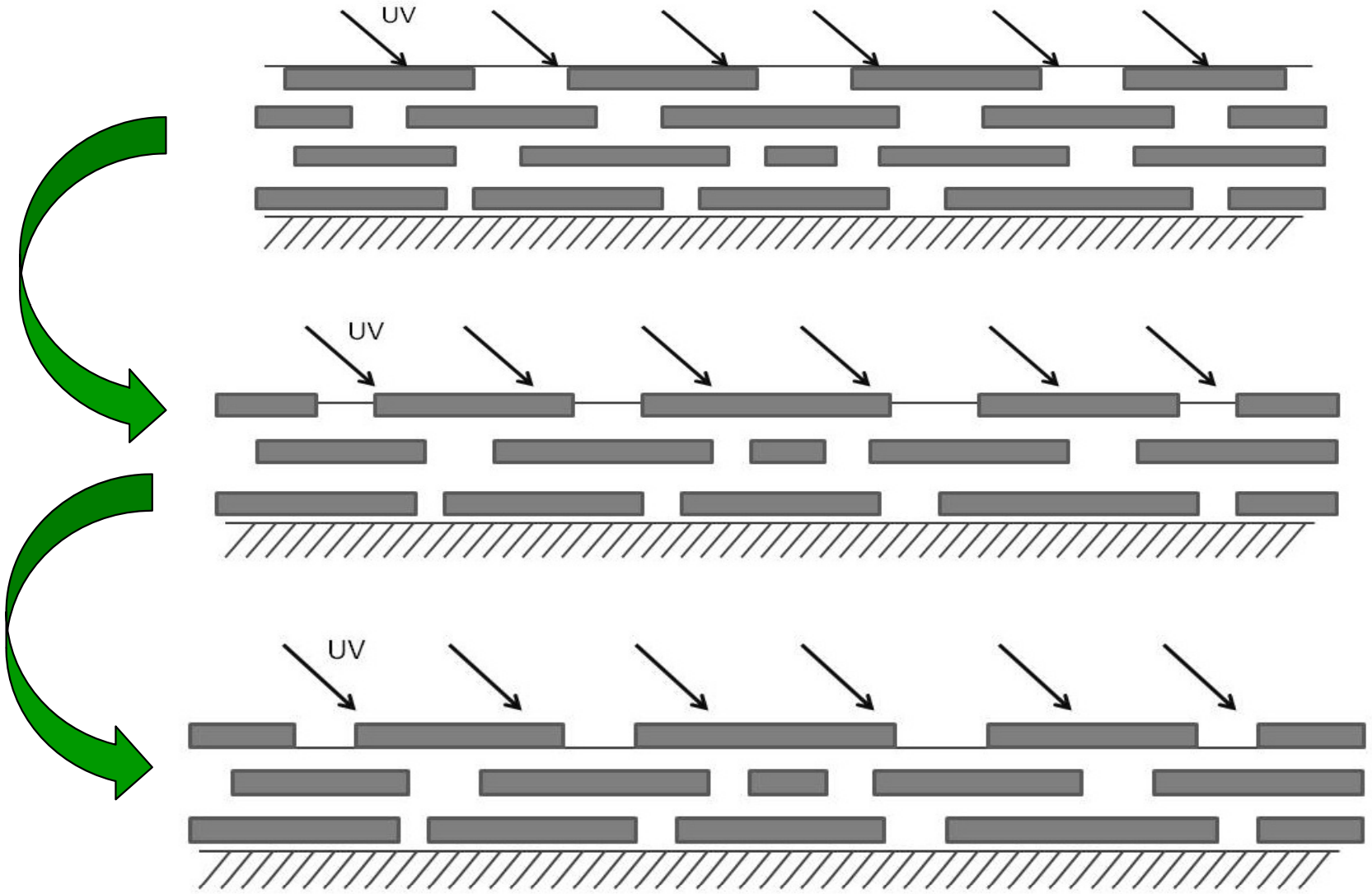
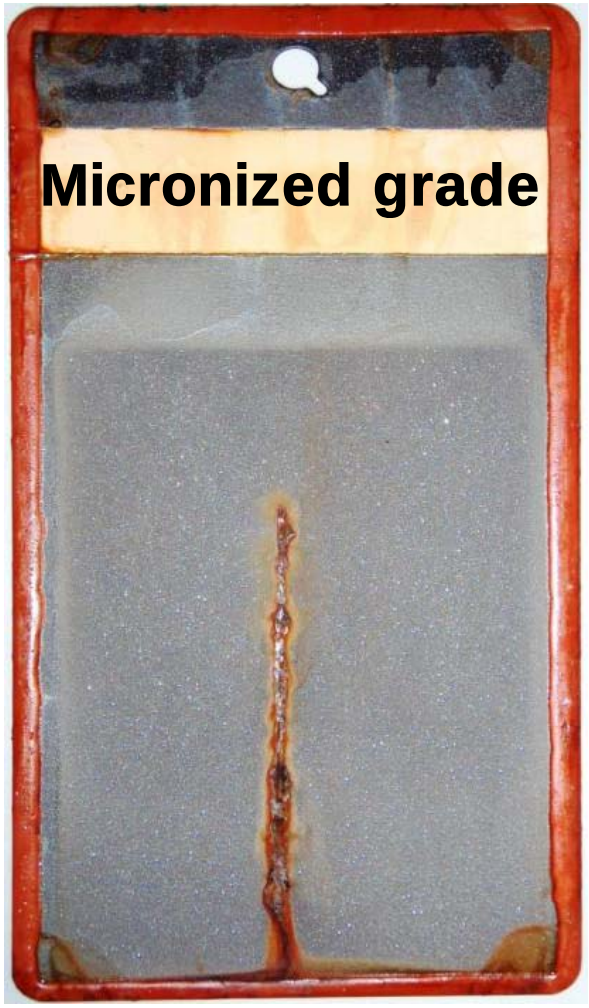


Enhanced anti corrosive performance of micronized grades



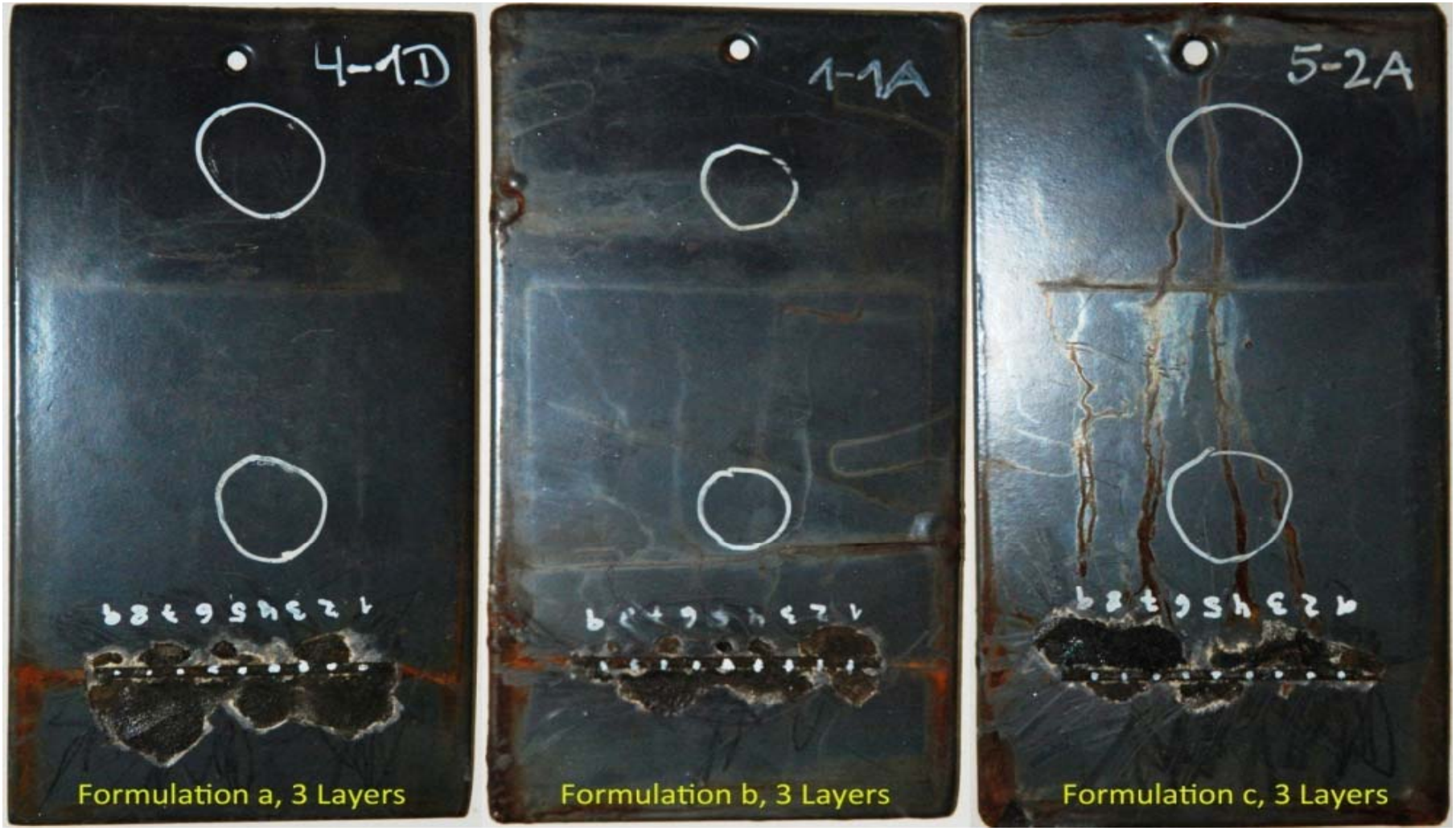
Adapted Formulations and Systems

- 2 and 3 layer system
  - Prime coat with Zn-phosphate (dft 60 microns)
  - Second Coat: *formulation a*: filled with standard MIOX, **content 40%, dft 100 microns**, formulation according to DB-TL 918 300
  - Second Coat: *formulation b*: filled with micronized MIOX, **content 24%,** dft 100 microns, MIO was partially substituted by a micronized talc grade , to keep the pvc constant)
  - Second Coat: *formulation c*: filled with micronized MIOX, content 40%, **dft 50 microns**
  - Optional: Third coat PU (dft 60 microns)

Adapted Formulations and Systems

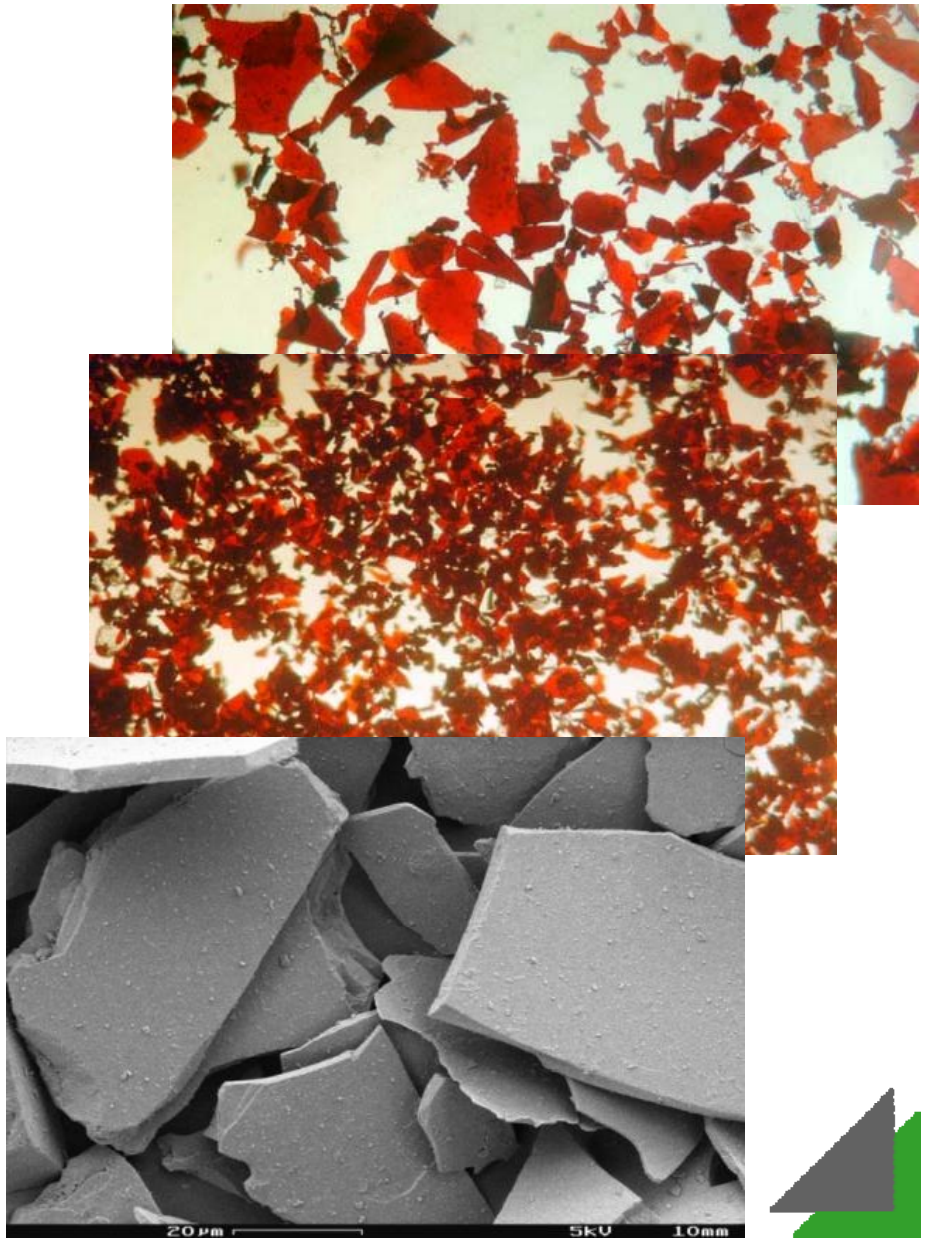
Test method	formulation a	formulation b	formulation c
Blistering DIN EN ISO 4628-2	0 (0)	0 (0)	0 (0)
Rusting DIN EN ISO 4628-3	Ri 0 (Ri 0)	Ri 0 (Ri 0)	Ri 0 (Ri 0)
Delamination / Corrosion on scratch DIN EN ISO 4628-8	5,8mm/3,2mm (6,2mm/2,8mm)	1,6mm/1,4mm (5,3mm/2,8mm)	6,4mm/3,4mm (3,8mm/3,0mm)

Adapted Formulations and Systems



New applications for micronized MIOX grades

- Systems with enhanced anti corrosive performance
- Coatings with reduced MIO content (water based anti corrosive coatings)
- Thin film anti corrosion systems
- Partial replacement of active pigments (Zinc dust) in prime coatings
- Improvement of prime coatings
- High temperature anti corrosive coatings
- Powder coatings



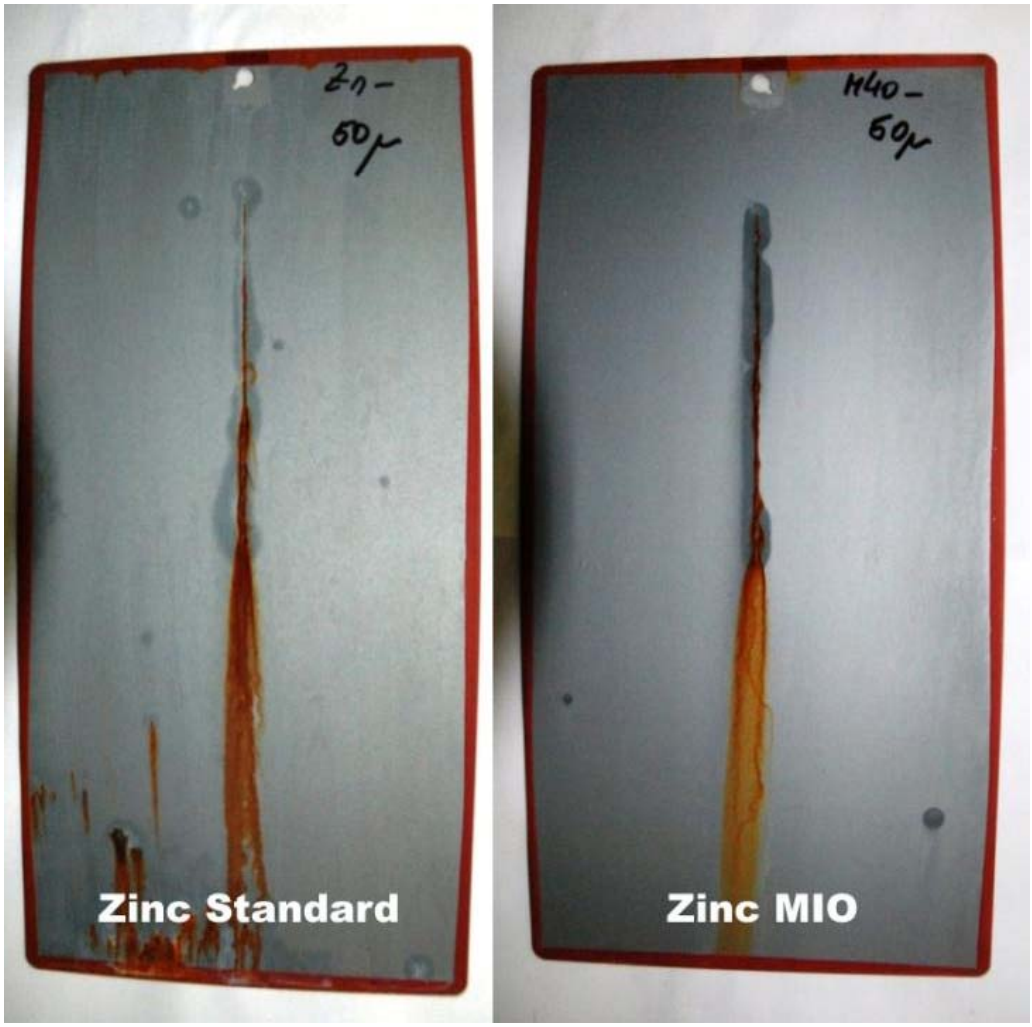
Water Based Anti Corrosive Coatings

- Rheological Problems
  - High density mineral
  - Quite coarse

→ Micronized MIO
  - 50% reduction in the formulation
  - Appr. 3 times finer; lower settling rate
  - Lower influence on color and gloss

Partial Replacement of Zn-Dust with micronized MIO

- Partial replacement (up to 50%) is possible
- Environmental advantages with green products (reducing Zn-content)
- Reduced Zinc salts
- Better adhesion on difficult substrates
- Money saving solution in case of high Zinc prices



Formulation Example

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MIOX – Technical Information B-07/11

2-Pack Ethylsilicate Zinc MIOX Primer
grey

	Component 1	weight % I	weight % II	Supplier
1	Hydrolysate 4 (Silicate 2253)	16,0	14,0	
2	Pioloform® BN 18 / 25%	3,0	3,0	
3	Fumed Silica HDK H15			
4	MIOX® Micro 40			
5	Hydrolysate 4	2,0	4,0	
6	Methoxypropylacetate	3,0	3,0	BASF
7	Xylene	2,0	2,0	
		55,0%	42,5%	
	Component 2			
8	Zinc dust Standard 601®	45,0	57,5	Conmet
		100,0%	100,0%	

3	Fumed Silica HDK H15	2,0
4	MIOX® Micro 40	27,0
5	Hydrolysate 4	2,0
6	Methoxypropylacetate	3,0
7	Xylene	2,0
		55,0%
	Component 2	
8	Zinc dust Standard 601®	45,0

Manufacturing instructions:

Stir 3 and 4 into the resin solution 1 and 2 and disperse for about 20 - 30 minutes at a peripheral speed of about 20 m / sec in a high speed disperser, then stir in 5 – 7.

Zinc dust 8 as component 2 is to be stirred into component 1 short before using the paint.

Improved Prime Coatings

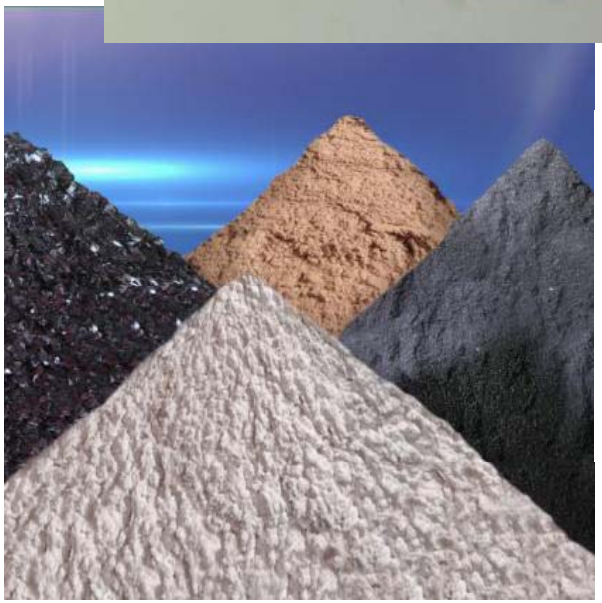
- Partial replacement of filler with micronized MIO (appr. 5%)
- Enhanced anti corrosive performance
- Cost / performance ratio!

Heat resistant anti corrosive coatings

- Limited temperature stability of active pigments (e.g.: melting point Zinc dust 420°C)
- Melting point of MIO 1,400°C
- Coatings for automotive applications (mufflers)
- Coatings for barbecue grills

Powder coatings

- Decorative effects
- Anti corrosive Coatings



Conclusions

- MIO is a typical functional mineral which outperforms other lamellar minerals
- Product quality, especially the content of lamellar particles is a crucial factor and decides about the coatings performance
- New micronized grades offers a range of new applications
  - Improved anti corrosive performance
  - Partial replacement of Zinc in prime coatings
  - Water based anti corrosive coatings
  - Thin film coatings
  - Improved prime coatings
  - Heat resistant anti corrosive coatings
  - Powder coatings

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