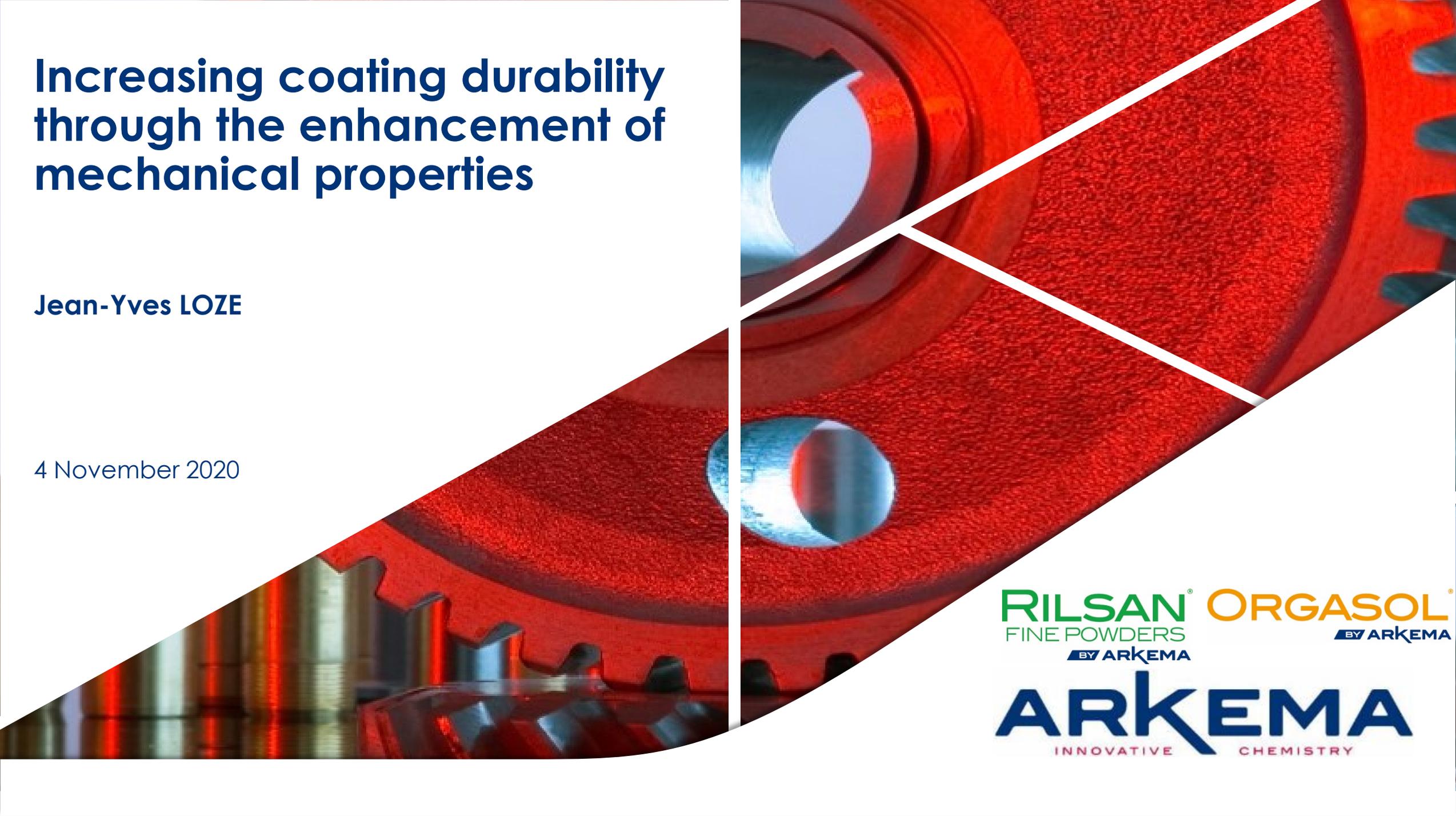


Increasing coating durability through the enhancement of mechanical properties

Jean-Yves LOZE

4 November 2020



RILSAN[®] ORGASOL[®]
FINE POWDERS BY ARKEMA

ARKEMA
INNOVATIVE CHEMISTRY

COATING - KEY PROPERTIES FOR AN IMPROVED DURABILITY

→ Coatings requirements:

- **Whole range of finishes:**
 - Glossy, satin to matte
 - Smooth to textured finish
- **Ensure protection of the substrate while keeping the finishing of the coating**
 - High scratch & abrasion resistance
 - Good rub and burnishing resistance
 - Excellent stain & chemical resistance



INCREASING COATING DURABILITY THROUGH THE ENHANCEMENT OF MECHANICAL PROPERTIES

→ Agenda

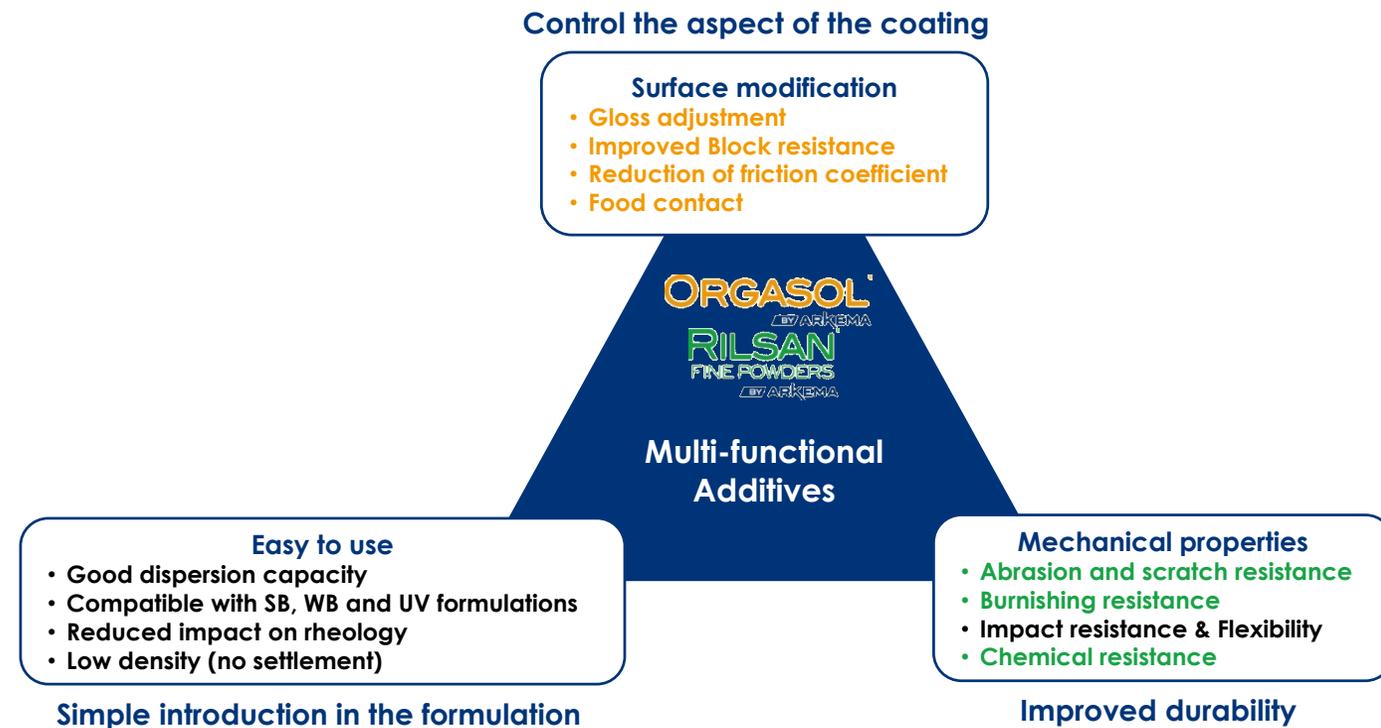
- **Surface modification using Orgasol® and Rilsan® polyamide powders**

- Mechanism of modification of the surface
- Incorporation of polyamide powders in formulations
- Example:
 - Deep matte 2K Solventborne wood coating

- **Mechanical properties improvement**

- Impact of polyamide particles on the coating mechanical properties and test results
- Abrasion resistance and scratch resistance
- Stain and chemical resistance
- Burnishing resistance

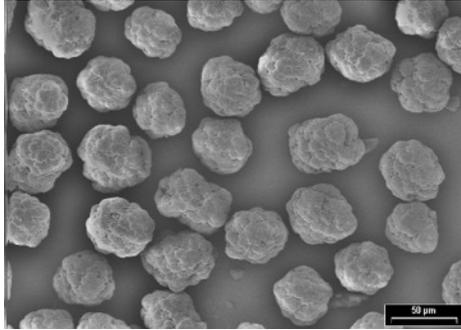
- **Conclusions**



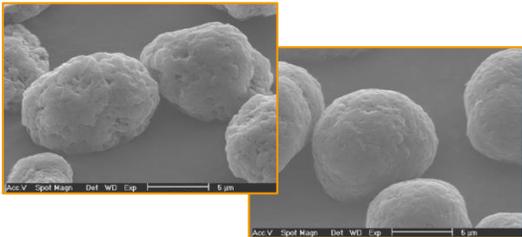
SURFACE MODIFICATION USING ORGASOL® AND RILSAN® POLYAMIDE POWDERS

PA 12, PA 6 and PA 6/12
based powder

ORGASOL®
BY ARKEMA



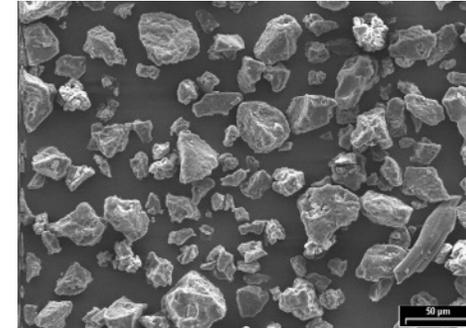
- ★ Unique spherical morphology & porous structure
- ★ Wide range of particle sizes available from 5 to 60 µm
- ★ Very narrow particle size distribution
- ★ Proprietary process: no grinding step



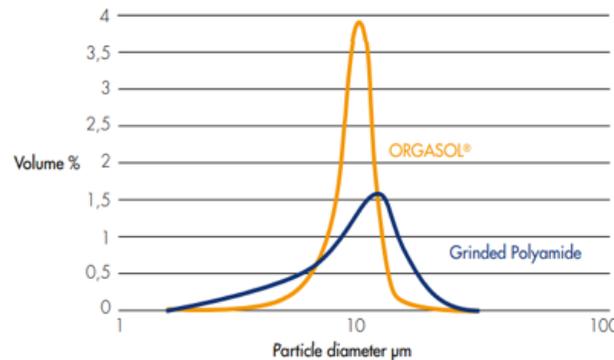
Unique 5, 10µm diameter particles
Control of the morphology
Lower PSD is achievable

PA 11
based powder

RILSAN®
FINE POWDERS
BY ARKEMA



- ★ Proprietary process from a renewable raw material
- ★ Wide range of particle sizes available from 20 to 100 µm
- ★ Mass-colored grades available
- ★ Specific grinding process



Castor plants



Castor seeds



Vegetal oil



Amino 11 (monomer)

RILSAN®
FINE POWDERS
BY ARKEMA

Polyamide 11

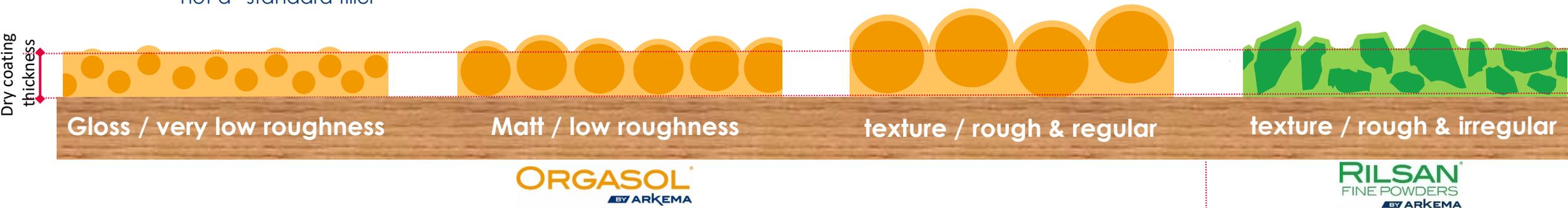
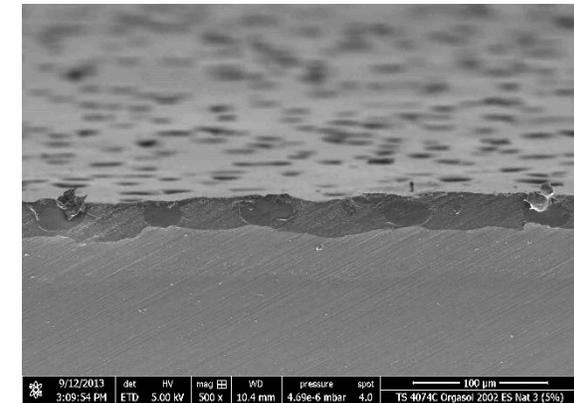
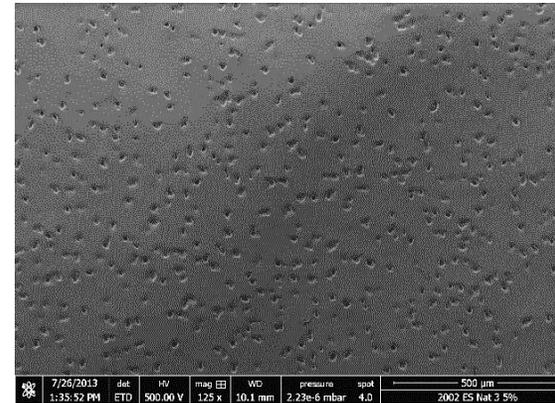
Requires less fossil energy and generate less CO₂ or other greenhouse gases than most performance polymers

SURFACE MODIFICATION USING ORGASOL® AND RILSAN® POLYAMIDE POWDERS

→ Mechanism of modification of the surface

- Polyamide particles create roughness at the surface of the coating

- Density of the polyamide powders close to 1
 - do not migrate at the surface or settle during drying
 - stay well dispersed in the bulk: no tendency to agglomerate
- Homogeneous modification of the coating
 - Isotropic coating
- Polyamide particle = semi-crystalline polymer particles
 - not a “standard filler”



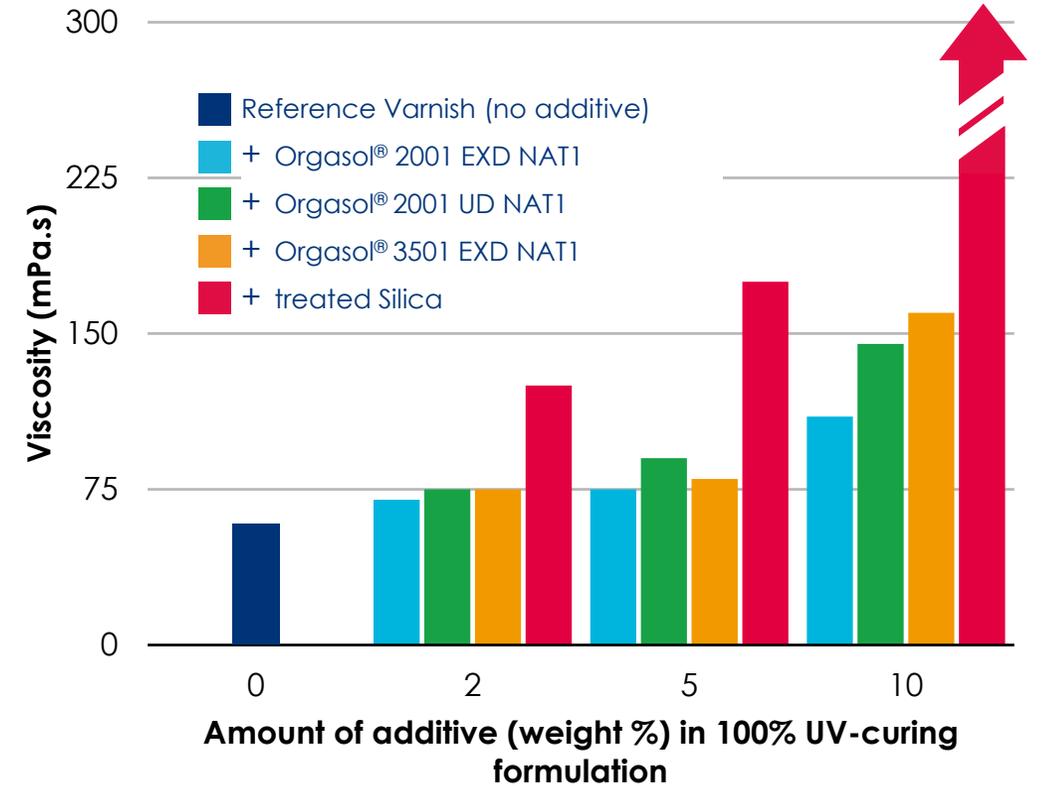
SURFACE MODIFICATION USING ORGASOL® AND RILSAN® POLYAMIDE POWDERS

→ Easy to use

- **Average polarity of polyamide**
 - Surface tension: 36 – 46 mN/m
 - easy to wet and disperse in many solvents and water
- **Low oil absorption**
 - Reduced impact on the viscosity of the formulation

→ Dispersibility

- **Can be added at any stage of the formulation**
 - Milling base
 - Letdown phase
- **Moderate shear rate is sufficient**
- **In most cases, no need for dispersing agent or wetting additives**
 - Most resins are good dispersion media for Orgasol® and Rilsan® Fine Powders
 - In some specific cases, a pre-dispersion (in water/solvent/UV monomer) can be used



SURFACE MODIFICATION USING ORGASOL® AND RILSAN® POLYAMIDE POWDERS

→ Aim: Formulate a deep matte clear coat (*Gloss <5GU at 85°*)

→ Starting from a formulation of a glossy clear coat

Weight composition % -	Formulation 1	Supplier
PART A		
Butyl Acetate	9.5	
SYNOCURE® 213 BA 50	34.4	
OCTA SOLIGEN ZINC 8%	0.1	Borchers
Butyl Acetate	16.7	
Solution CAB 381-2 (10% AB-PMA)	29.6	Eastman
BORCHI® GOL LAC 80 (10% in ethyl acetate)	0.2	Borchers
Matting agent: Orgasol®		
PART B		
DESMODUR® N75 BA	3.3	Covestro
Butyl Acetate	6.2	

Target:

→ Dry coating thickness: 30µm

→ Gloss: <5GU @60°, <8GU @85°

SURFACE MODIFICATION USING ORGASOL® AND RILSAN® POLYAMIDE POWDERS

→ Optimization of Orgasol® nature and amount in the formulation

	ORGASOL BY ARKEMA				Gloss (GU)		
	2001 UD Nat 2	2001 EXD Nat 1	2002 D Nat 1	2002 ES3 Nat 3	20°	60°	85°
reference					59	86	94
Formula 1	3				2	17	43
Formula 2		3			3	18	27
Formula 3			3		2	15	14
Formula 4				3	2	5	10
Formula 5	2,5		3		1	4	4

↓
 Gloss decrease
 Roughness increase



Combination of particles

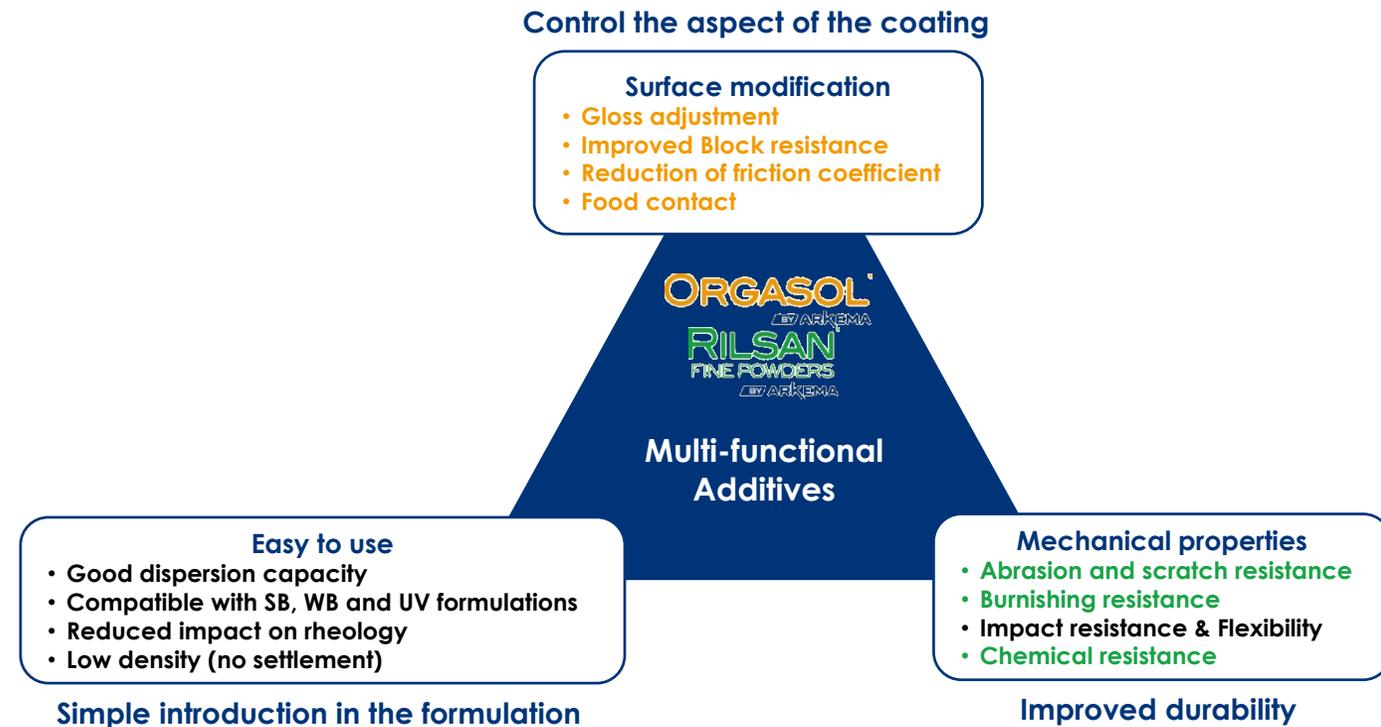
 Increased micro-roughness



INCREASING COATING DURABILITY THROUGH THE ENHANCEMENT OF MECHANICAL PROPERTIES

→ Agenda

- **Surface modification using Orgasol® and Rilsan® polyamide powders**
 - Mechanism of modification of the surface
 - Incorporation of polyamide powders in formulations
 - Example:
 - Deep matt 2K Solventborne wood coating
- **Mechanical properties improvement**
 - Impact of polyamide particles on the coating mechanical properties and test results
 - Abrasion resistance and scratch resistance
 - Stain and chemical resistance
 - Burnishing resistance
- **Conclusions**



IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Modification of the coating with polyamide particles

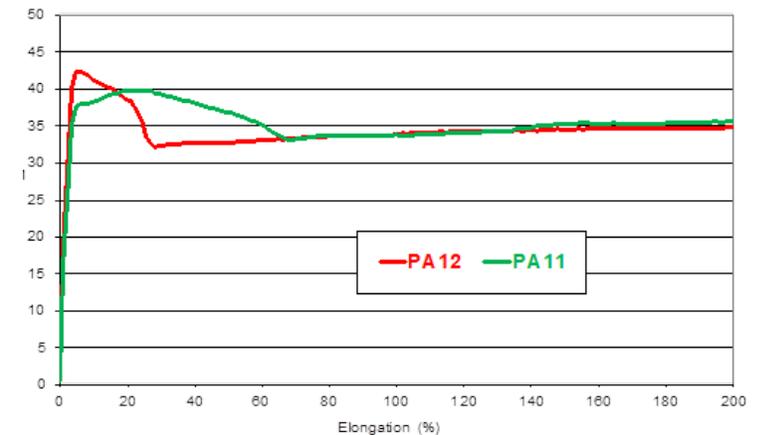
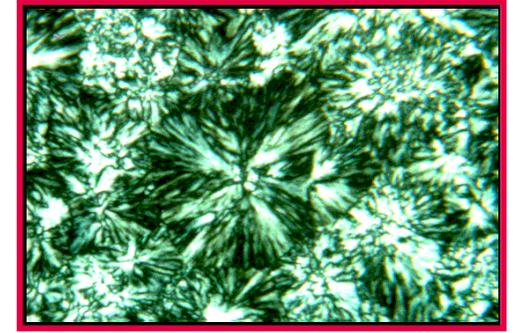
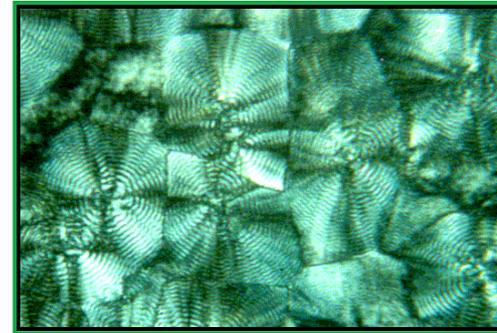
- **Polyamide chemistry**

- Modify the mechanical properties of the coating
- Non-reactive:
 - Do not react with the binders whatever the chemistry

- Intrinsic properties of the polyamide

- Semi-crystalline: hardness
- Long chain polyamide: flexibility and stiffness

Elongation at break $\geq 200\%$	PA12 & PA11
Tensile strength at break $\geq 40\text{MPa}$	PA12 & PA11
Tensile Modulus $>1200\text{ MPa}$	PA12 & PA11

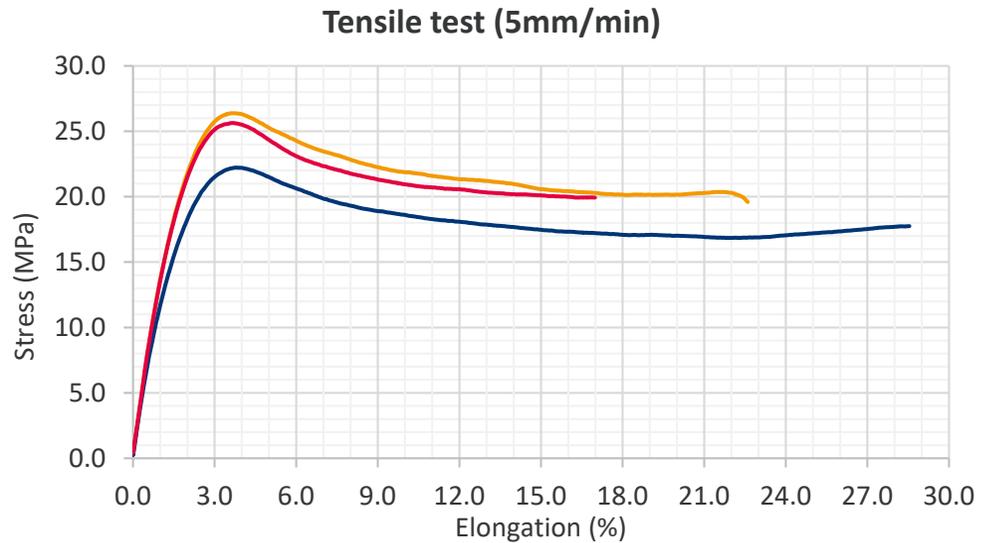


IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Modification of the coating with polyamide particles

• Modified coating

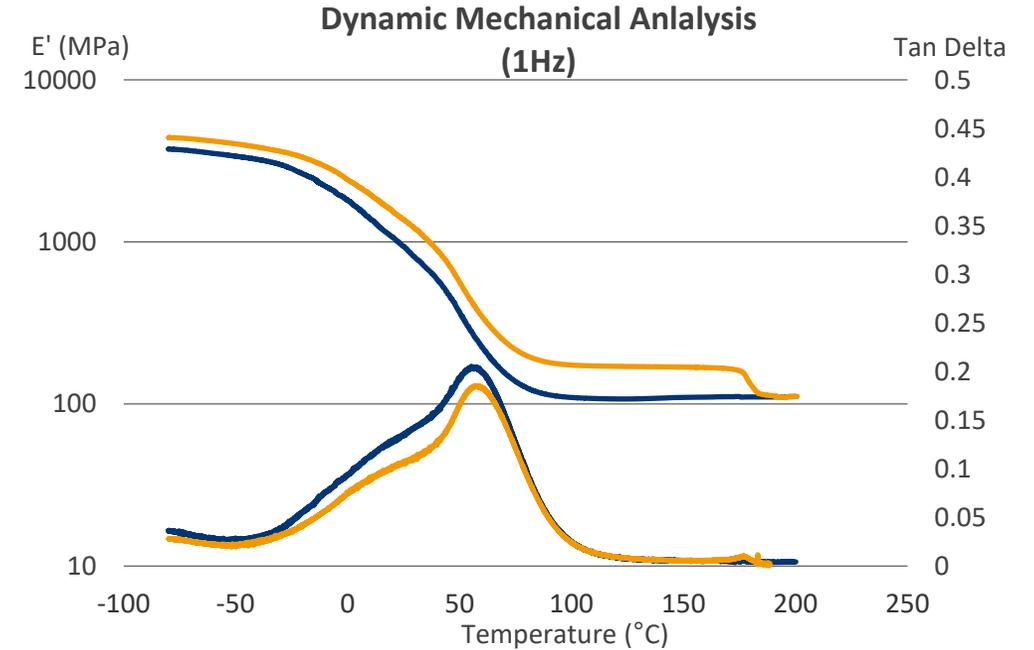
- Keeps a good flexibility
 - Key property for durability
- Is strengthened by the polyamide particles



UV varnish with silica

UV varnish with no PA

UV varnish with PA



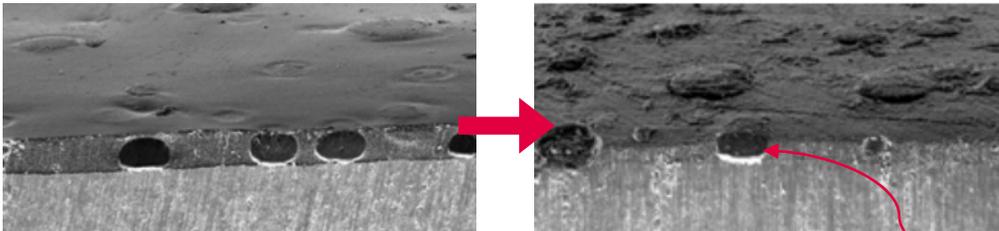
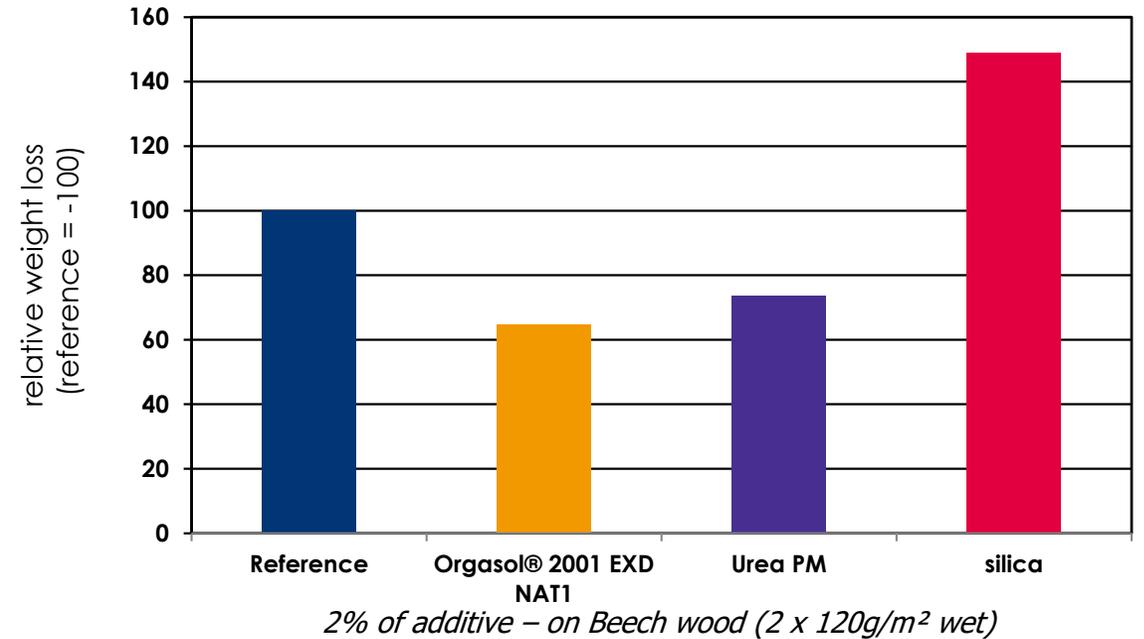
100% UV coating

IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Abrasion resistance

40 GU à 85° varnish	Function	% w/w	Supplier
Encor® 2171	Acrylic emulsion	83.5	
Byk®-028	Defoamer	0.4	Altana
Amonia 25%	pH regulator	0.08	-
Orgasol®	Matting agent	2.0	
Crayvallac® A2678M	Levelling agent	0.5	
Dowanol® PnB	Co-solvent	4,0	Dow
Dowanol® DPnB	Co-solvent	3,0	Dow
Coapur™ 6050	Rheological additive	0.3	
Deionized water		6.3	-

Taber test (CS-10 – 1000 grams – 500 cycles) done after 20 days @23°C



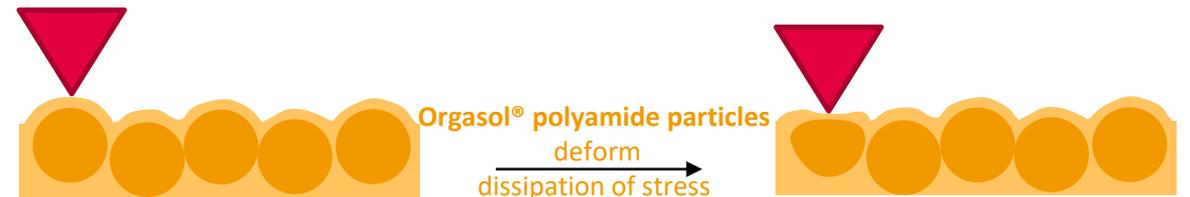
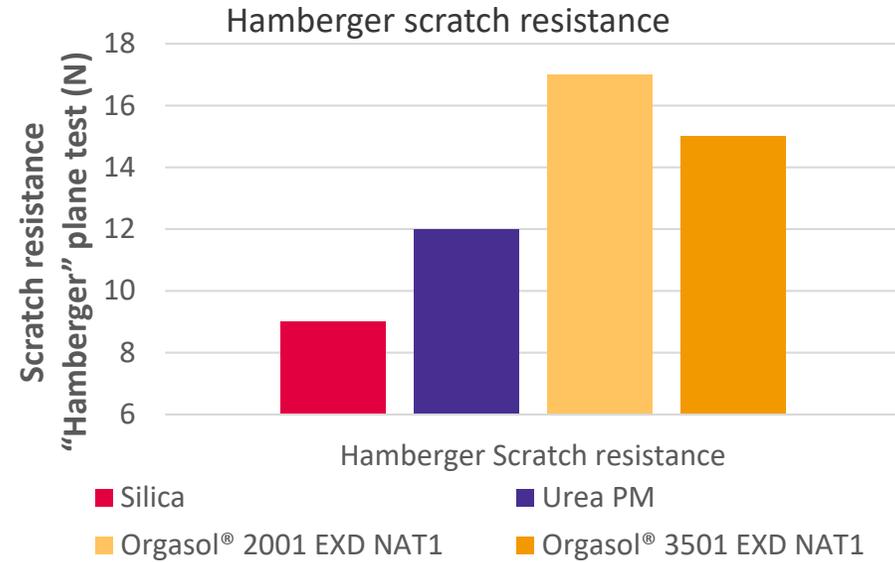
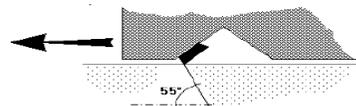
Orgasol® particles deform under stress, it is less abraded than the coating resin



IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Scratch resistance

40 GU @ 60° varnish	Function	% w/w	Supplier
Encor® 2718	Acrylic emulsion	77.5	ENCOR BY ARKEMA
Byk®-025	Defoamer	0.5	Altana
adjust pH at 8.0 - 8.54			
Coapur™ 830 W	Rheological additive	0.15	COAPUR BY ARKEMA
Coapur™ 2025	Rheological additive	1.6	BY ARKEMA
Orgasol® 3501 EXD NAT1	Matting agent	1.5	ORGASOL BY ARKEMA
Irgacure® 500	Photo-initiator	1.0	BASF
Butylglycol	Co-solvent	2.0	
Byk®-333	Wetting agent	0.2	Altana
Byk®-348	Levelling agent	0.4	Altana
Eencor® 7605	Acrylic emulsion	4.6	ENCOR BY ARKEMA
Deionised water		10.6	



IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Burnishing resistance

- Deep matte clear topcoat – starting point formulation

Weight composition % -	Formulation 1	Formulation 2	Formulation 3	Supplier
PART A				
Butyl Acetate	9.2	9.1	9.0	
SYNOCURE® 213 BA 50	33.4	32.9	32.5	
OCTA SOLIGEN ZINC 8%	0.1	0.1	0.1	Borchers
Butyl Acetate	16.2	15.9	15.8	
Solution CAB 381-2 (10% AB-PMA)	28.7	28.2	28.0	Eastman
BORCHI® GOL LAC 80 (10% in ethyl acetate)	0.2	0.2	0.2	Borchers
Silica	3.0	2.5		
ORGASOL® 2001 UD NAT2		2.0	2.5	
ORGASOL® 2002 D NAT1			3.0	
PART B				
DESMODUR® N75 BA	3.2	3.2	3.2	Covestro
Butyl Acetate	6.0	6.0	6.0	

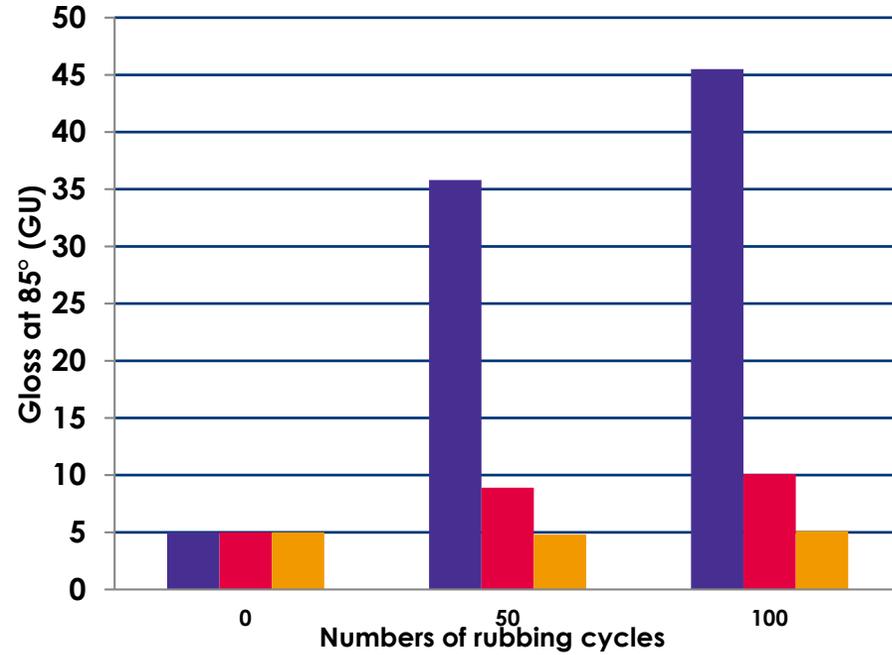
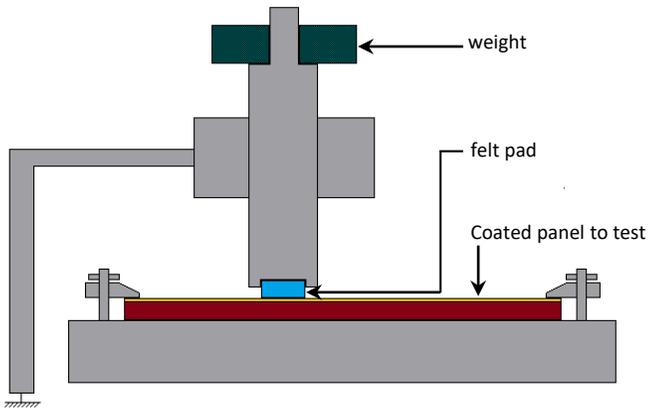
Max loading of Orgasol® to keep a non-hazy coating depends on the binder nature
Usually < 5,5%

IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

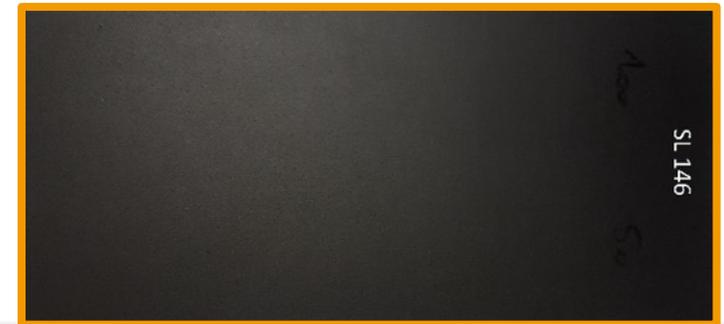
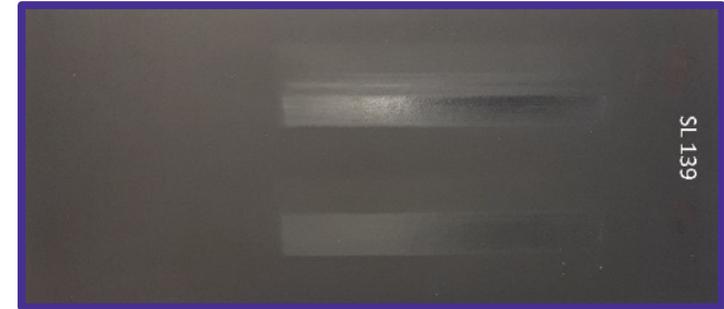
→ Burnishing resistance

- Principle:

- Gloss increase after rub cycles



- Formulation 1 (silica)
- Formulation 2 (silica + Orgasol®)
- Formulation 3 (pure Orgasol®)

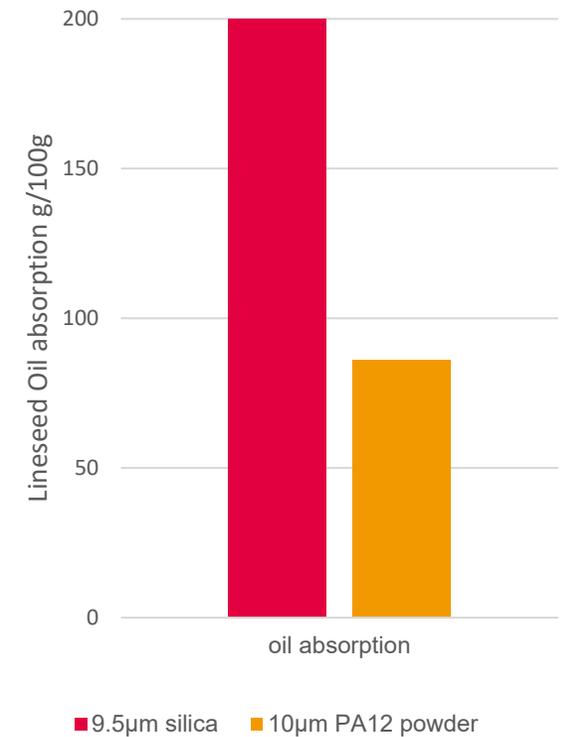
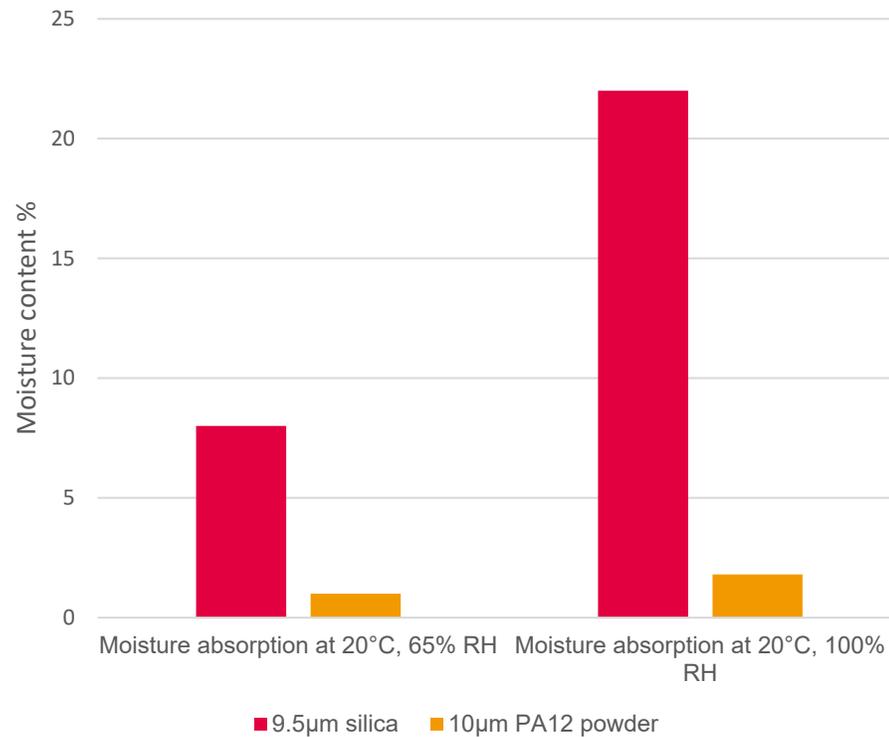


IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Stain and chemical resistance

• Polyamide chemistry

- Long chain polyamide
- PA12 and PA11 are hydrophobic polymers
- Insoluble in most organic solvents:
 - aromatic hydrocarbons,
 - ether,
 - acetone,
 - chlorinated solvents
- Very low water absorption
- Very low oil absorption



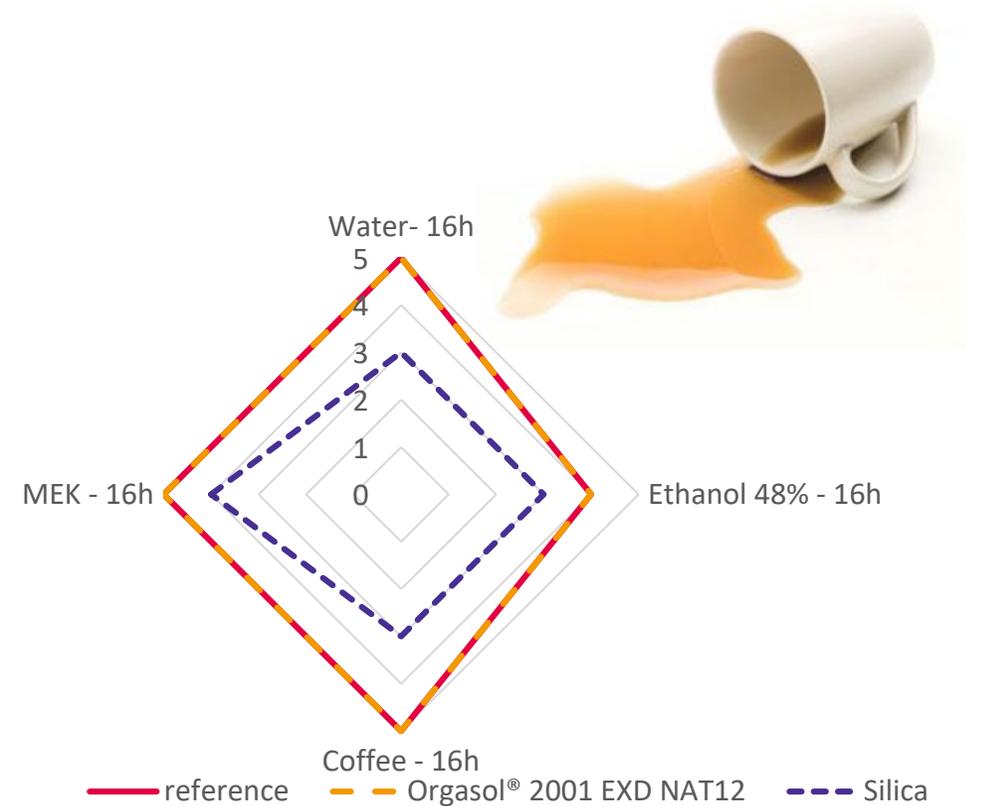
IMPACT OF POLYAMIDE PARTICLES ON THE COATING MECHANICAL PROPERTIES

→ Stain and chemical resistance

• Waterborne UV clear varnish

Weight composition	Formulation	Function	Supplier
Encor [®] 2718	77.1	UV-curable acrylic emulsion	
Byk [®] -025	0.5	Defoamer	Altana
Sodium hydroxide solution : Adjust pH at 8-8.5		pH regulator	
Coapur [™] 830W	0.15	Rheological additive	
Coapur [™] 2025	1.6	Rheological additive	
Orgasol [®] 2001 EXD NAT1	2.1	Matting agent	
Irgacure [®] 500	1.0	Photo-initiator	BASF
Butylglycol	2.0	Co-solvent	
Byk [®] -333	0.2	Levelling agent	Altana
Byk [®] -348	0.4	Wetting agent	Altana
Encor [®] 7605	4.6	Wax emulsion	
Deionized water	10.5	Solvent	

- Viscosity (Ford cup 4) = 60 +/- 5 seconds
- pH = 8.0 – 8.5
- 2 coats of 100 gr/m² - Forced drying = 10mn 45°C + UV CURING



INCREASING COATING DURABILITY THROUGH THE ENHANCEMENT OF MECHANICAL PROPERTIES

→ Conclusions

- **Surface modification using Orgasol[®] and Rilsan[®] polyamide powders**

- Satin to deep matt wood coating
- Smooth to textured coating



playing on the particle size of the Polyamide powder versus dry coating thickness

- **Mechanical properties improvement**

- Increased Yield strength and Elastic modulus, while keeping flexibility
 - Improved abrasion resistance and scratch resistance
 - Improved burnishing resistance
 - Equivalent stain and chemical resistance

- **Long chain Polyamide 12 and 11 powders**

- improve the durability of the coating
- solve multiple issues for the coating formulator



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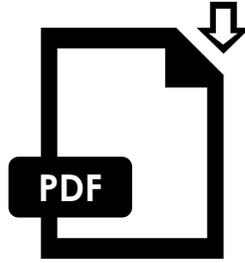
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