Synthetic clays at 60: Pioneering Rheological solutions for superior wood coatings

Dr. Neil Grant, BYK Additives Ltd.

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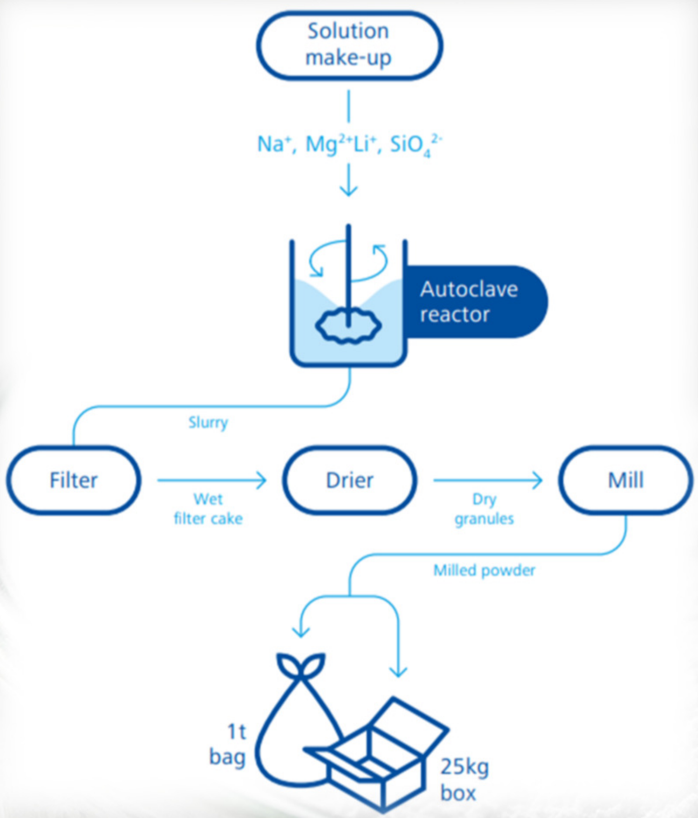
Hydroclays – Introduction
Synthetic clay-based additives

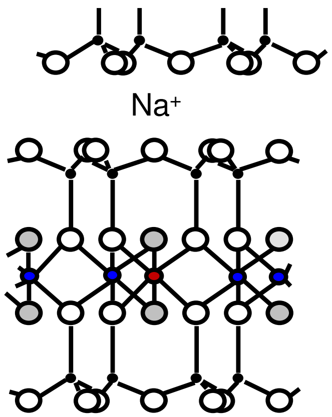


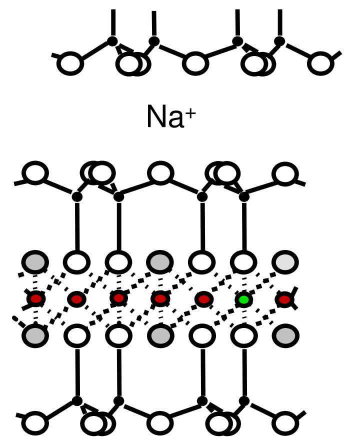
- **Synthetic clay** products are based on a 100 % natural origin, carbon free synthetic hectorite
- They are characterized by very high purity, consistent performance, and high efficiency
- Furthermore, they are remarkable within BYK’s clay-based product portfolio for their ability to form colorless gels and dispersions, that leave a clean, dry feel

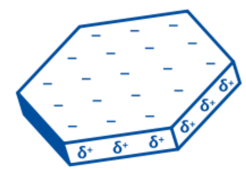
Phyllosilicates – Introduction
Natural & synthetic smectites

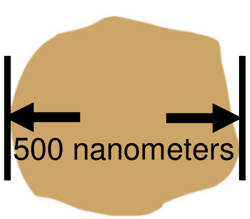
Layered silicates - smectites

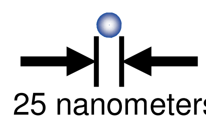
Natural clay	Synthetic phyllosilicates
Montmorillonite	**Hectorite**
$(Al_{3.2}Mg_{0.8})(Si_8)O_{20}(OH)_4Na_{0.8}$	$Na_{0.7}^{+}[(Si_8Mg_{5.5}Li_{0.3})O_{20}(OH)_4]^{0.7-}$











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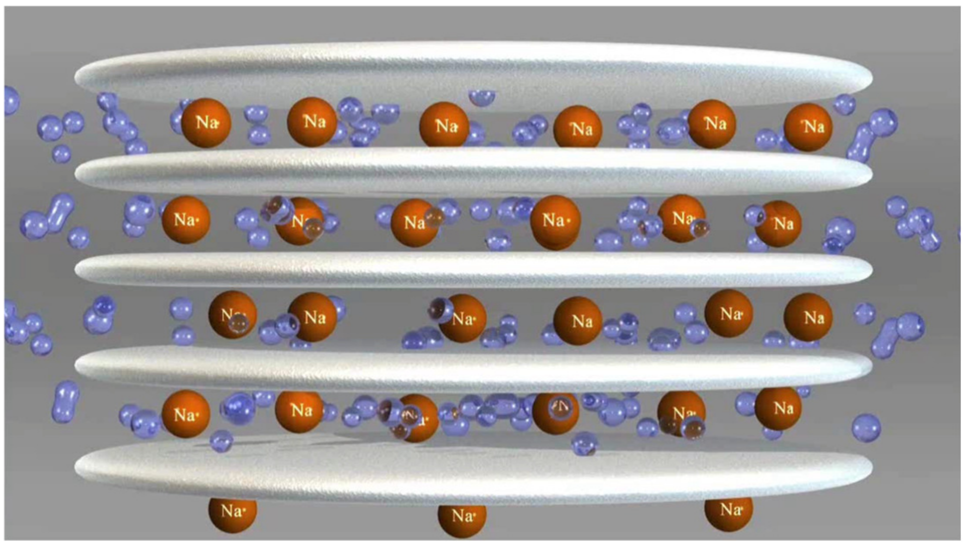
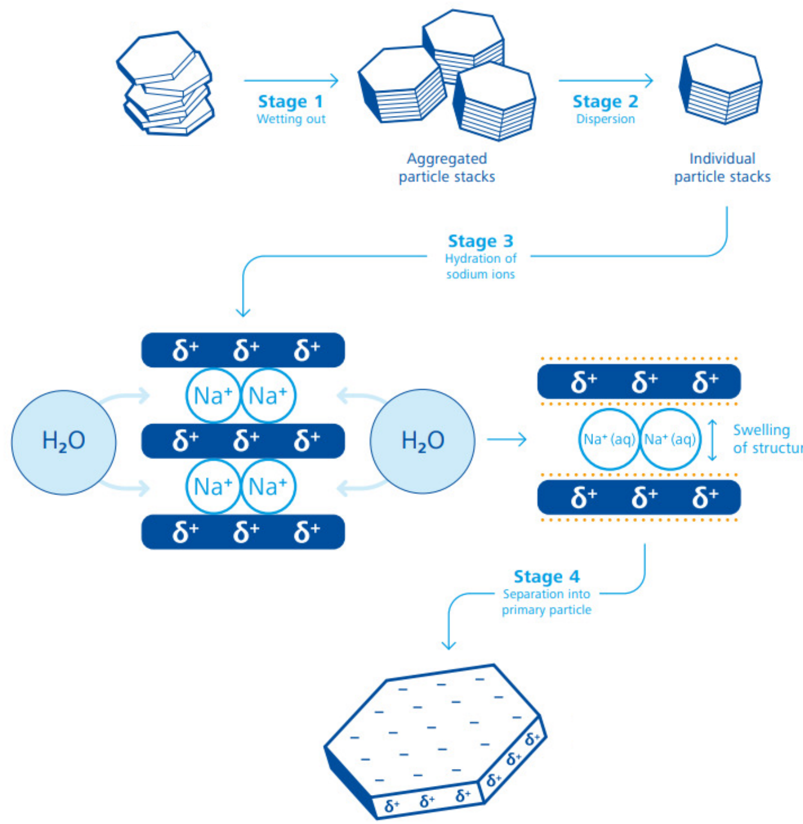
Phyllosilicates – Introduction
Hydration and rheology mechanism





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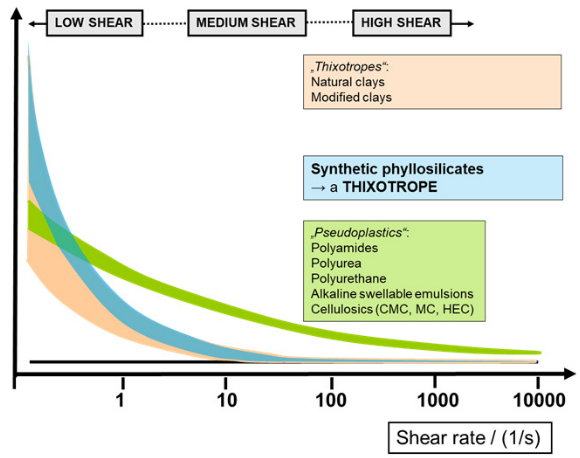
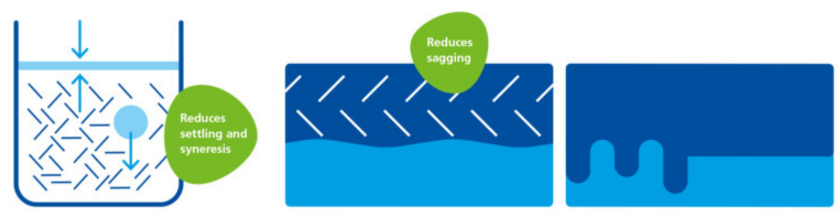
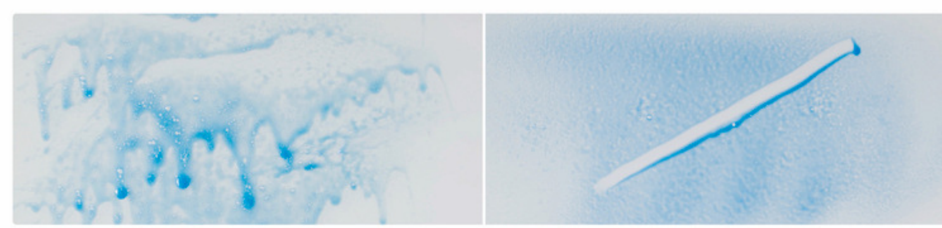
Synthetic Phyllosilicate Rheology *Plus* core performances

- ✓ Extremely **shear thinning**
- ✓ **High low shear viscosity** i.e., good suspension properties
- ✓ **Spray-with-cling** properties
- ✓ Excellent pigment **orientation**, reduced **pigment flocculation** on substrate
- ✓ Synergy with polymers e.g., CMC, HASE, Xanthan Gum
- ✓ High **clarity**
- ✓ High product **purity** & consistency
- ✓ Performance across the full pH range
- ✓ Safe to use and non-toxic
- ✓ Charged platelets provide barrier and anti-static properties to coatings
- ✓ Temperature stable







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Rheology
Pseudoplasticity

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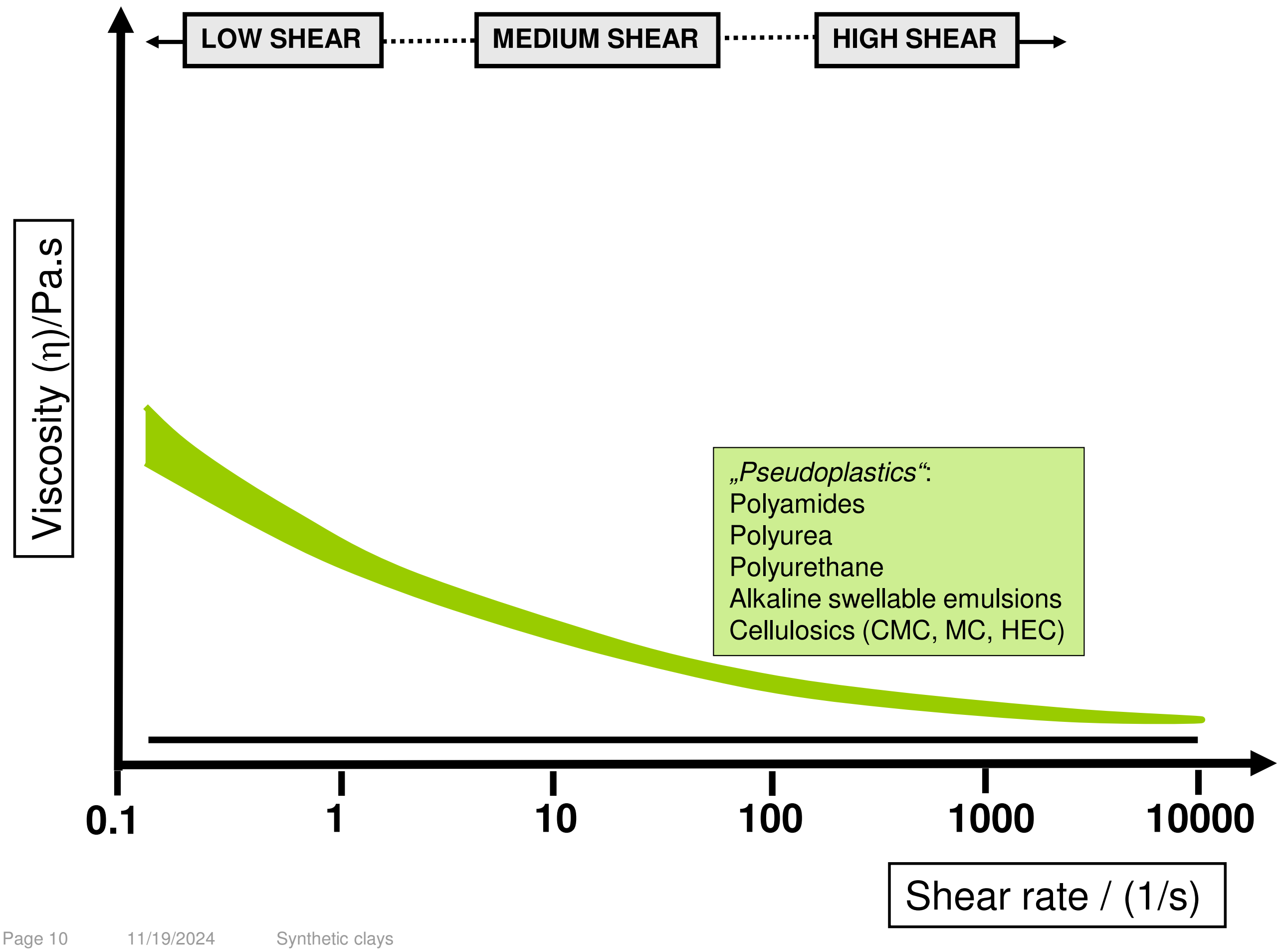
Rheology
Overview



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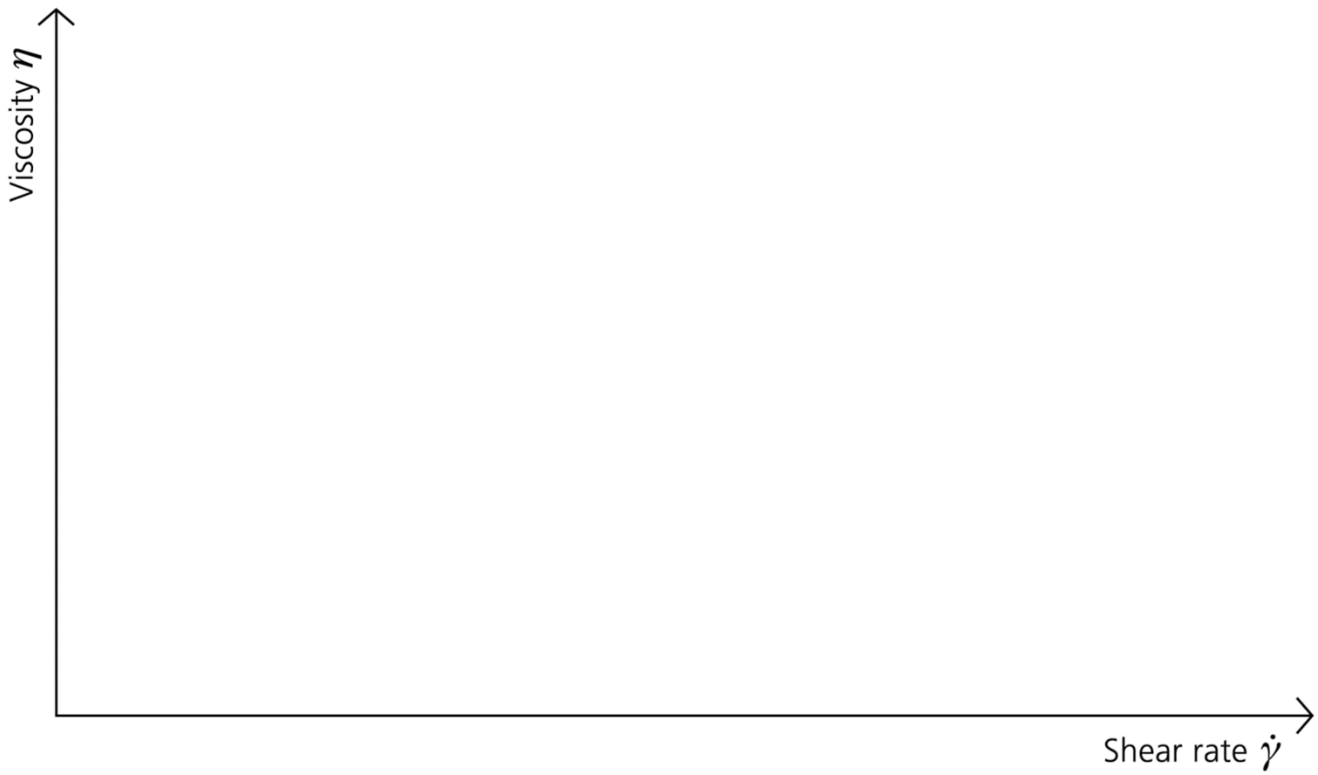
Rheology
Thixotropy



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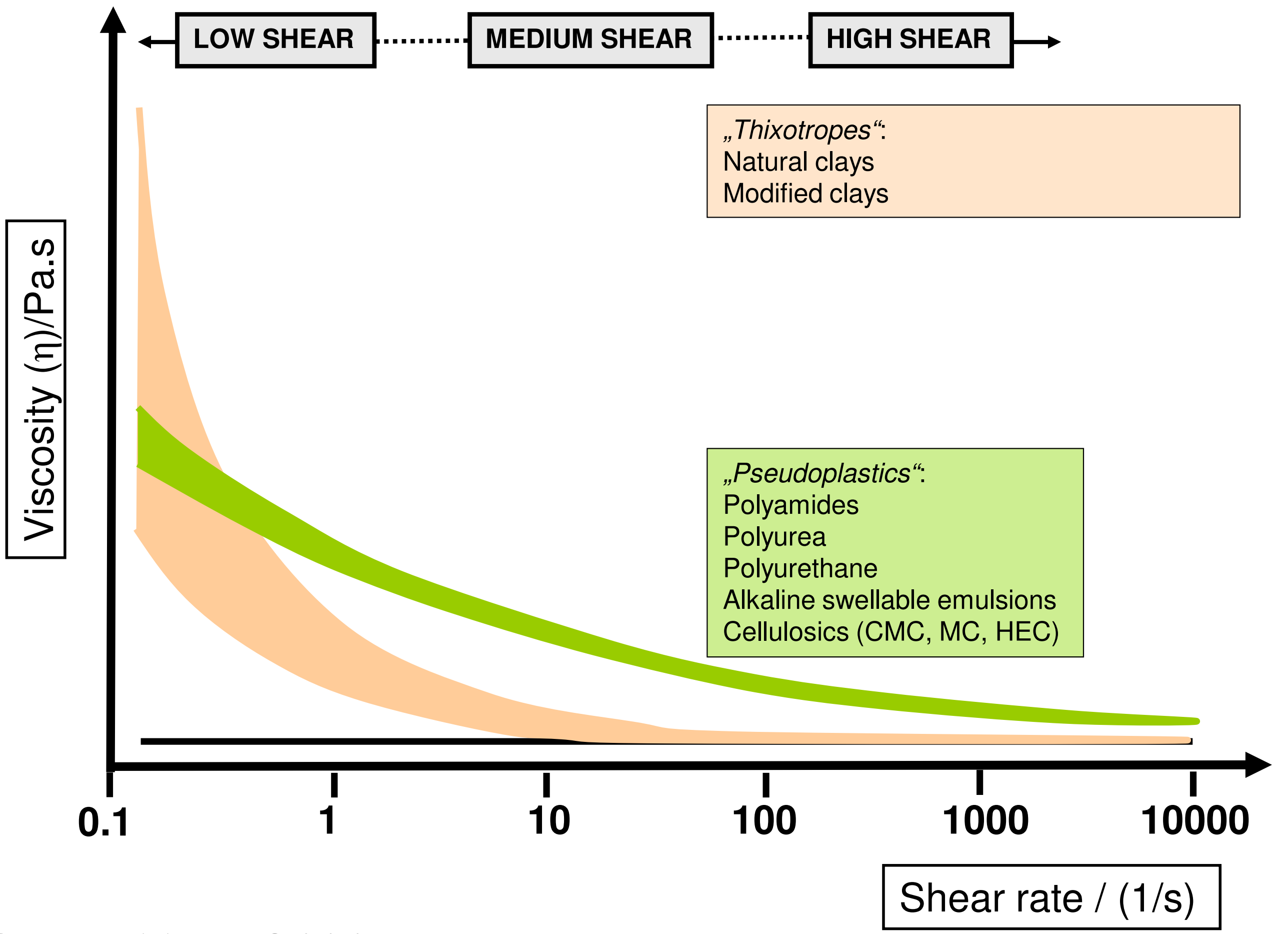
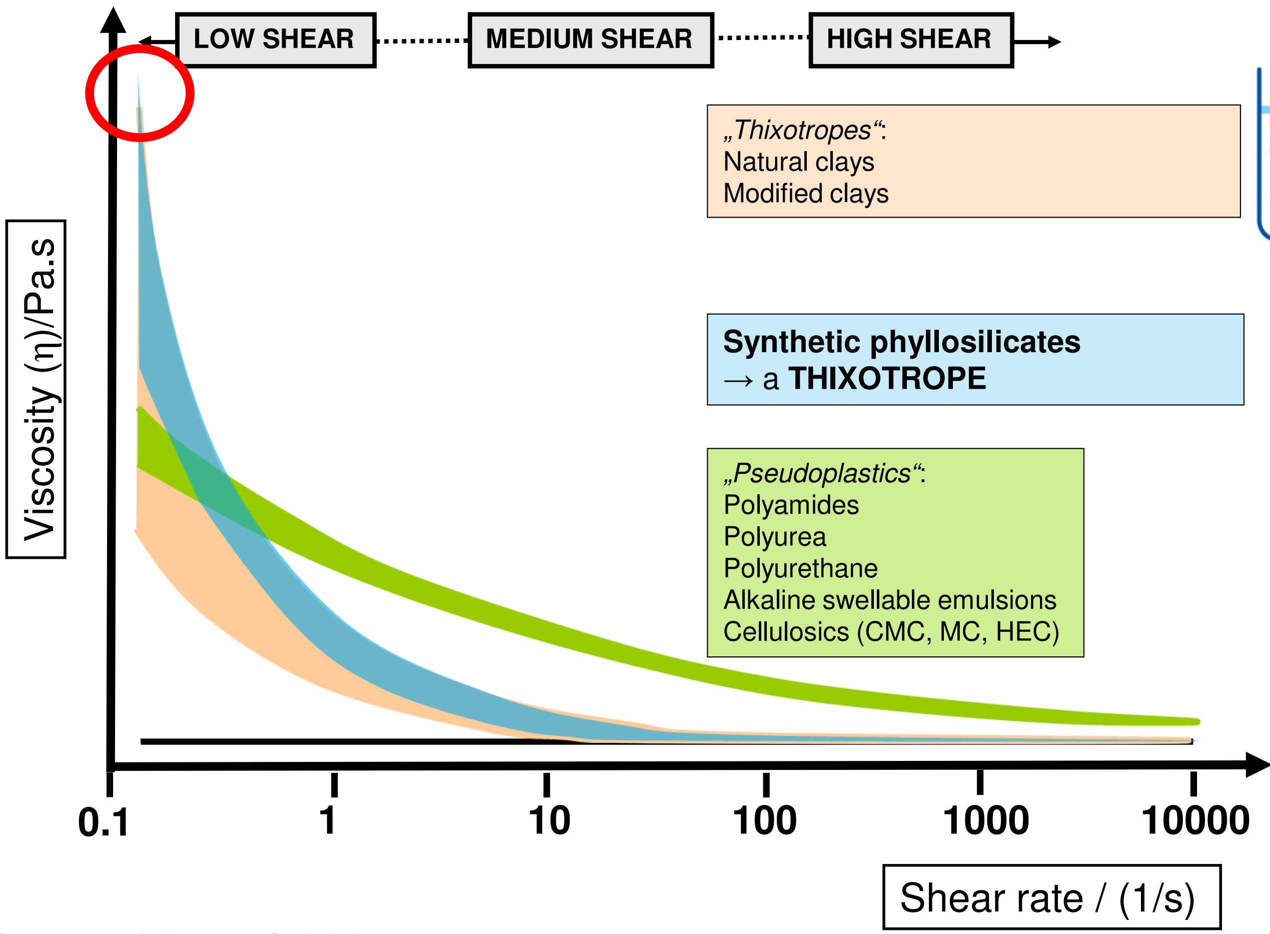
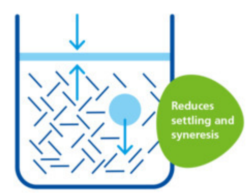
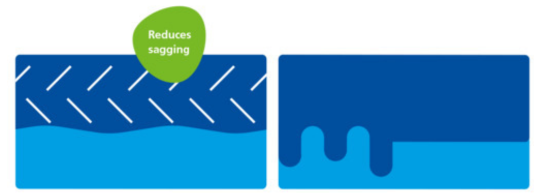
Rheology
Overview



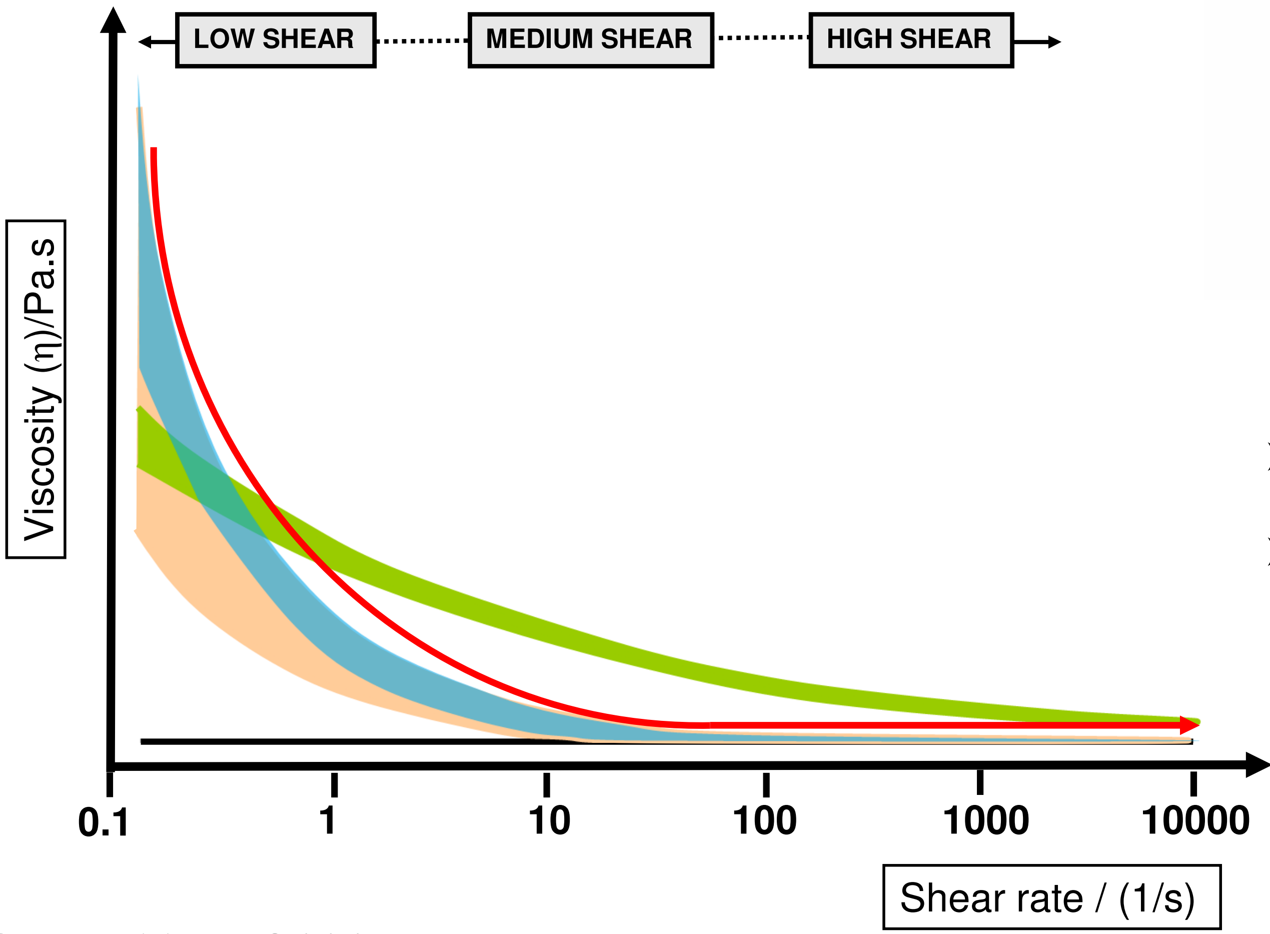
Rheology
Property – Suspension and anti-settling/syneresis





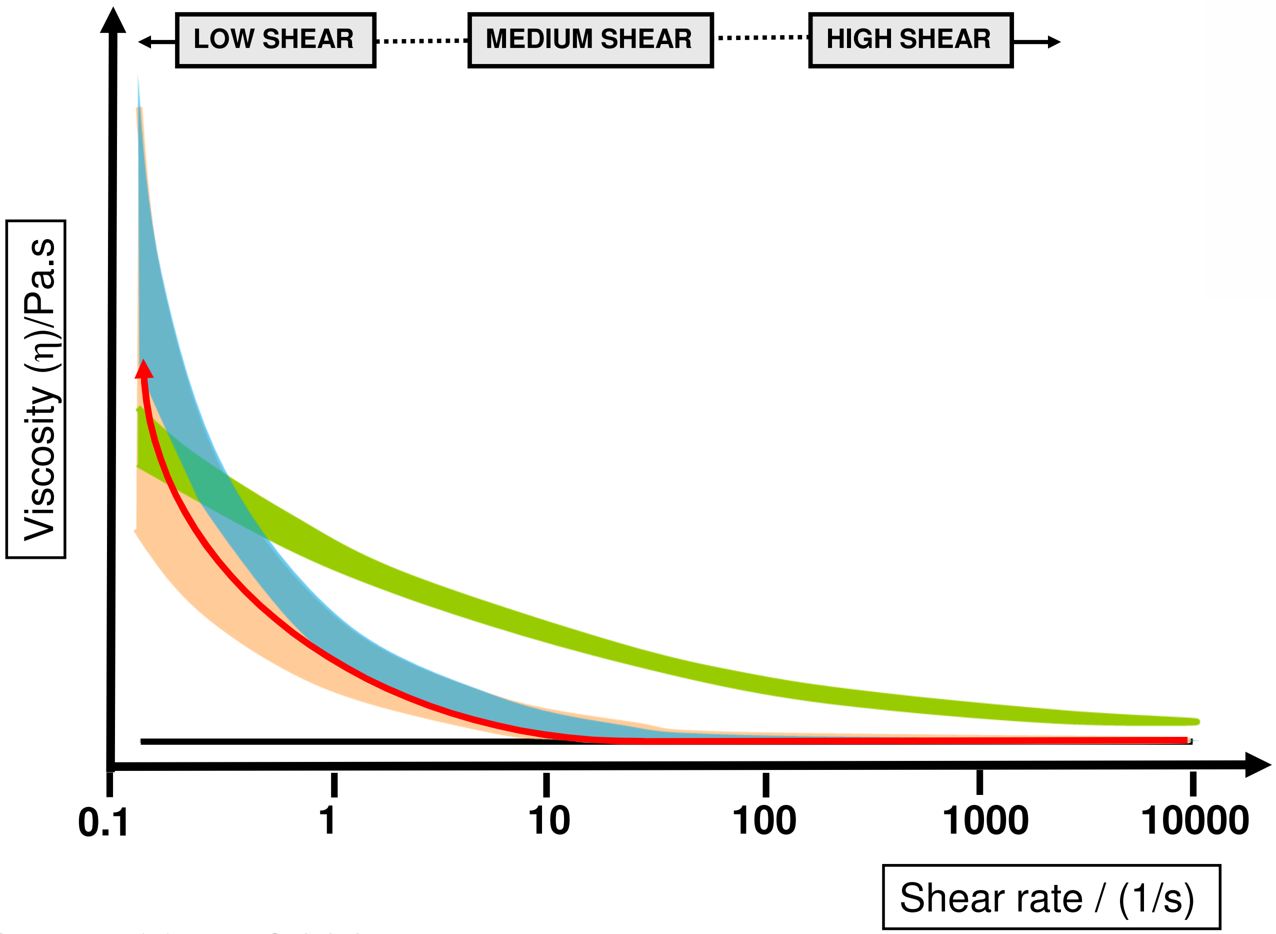


Rheology
Property – Extreme shear thinning



- ➢ Highly shear thinning for easy application
- ➢ (Spray nozzles, brush, roller etc)

Rheology
Property – Unique structure regeneration



Unique structure recovery that allows compromise between **levelling** and **sag resistance**

- **Arrangement** of pigments on a substrate
- No running down the surface after spray

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Synthetic clay-based additives
Dispersion procedure

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Pigment concentrates
General formulation

Position	Function	Weight [%]
1	Water	20.1
2	Synthetic (modified) phyllosilicate	0.2
3	Wetting and dispersing	8.1
4	Defoaming	1
5	Urea Thickener	0.5
6	Preservation	0.1
7	Pigment	65
8	Water (Let-down)	5
Total		100

Characteristic Data
Additive Dosage (solid on pigment)
5%

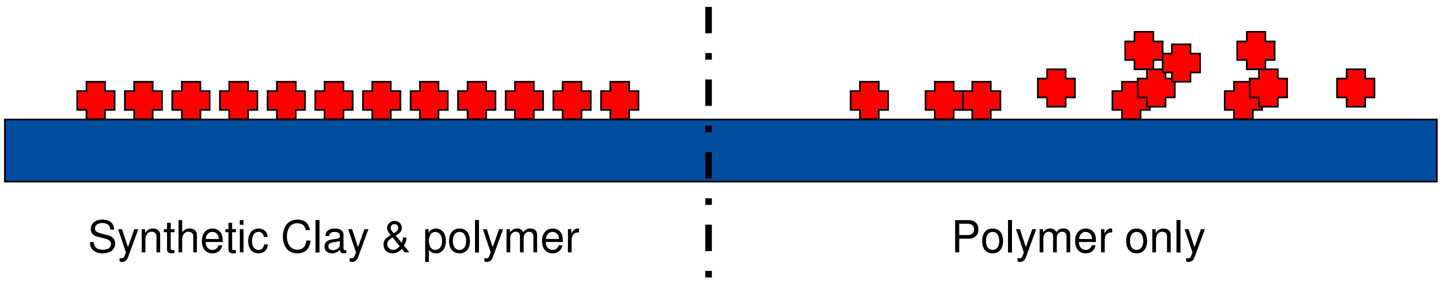
Instructions
- Disperse synthetic phyllosilicate for 15-20 minutes
- Add position 3 – 7 under mixing.
- Disperse the pigment gradually into the mixture over 20 minutes. Increase the stirrer speed to keep dispersion flowing.
- Add position 8 let-down water.

Control, no additives - sedimentation

0.2% Phyllosilicate No Sedimentation Easy to stir Easy to dose

Features/Benefits:
- Increased efficiency
- Stability without excessive viscosity
- No impact on color acceptance

Synthetic clays in pigmented systems
Wiping Stains: more wood warming – less pigment paste needed

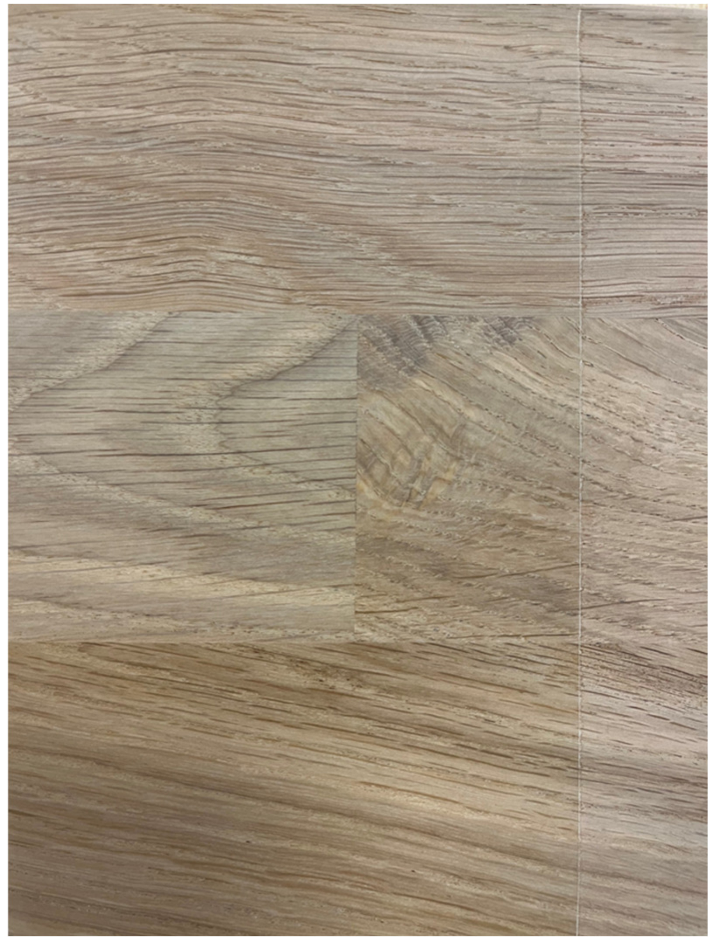


Position	Component	Weight [g]
1	Water	58
2	Synthetic Clay	0.3 - 1
3	HEC	0.3
4	Propylene glycol	2.3
5	Texanol	0.6
6	Preservatives	0.1
7	Acrylic emulsion	21.8
8	Water	11.2
9	Pigments	4.7

Features/Benefits:
- Improved pigment spacing on surface
- Better wood warming
- Less pigment required

Matting – stabilisation of matting agent/waxes
General formulation

Position	Function	Weight [%]
1	Water	19.5
2	Synthetic phyllosilicate	0.5
1	Hybrid-dispersion	64
2	Glycol ether 1	6.5
3	Glycol ether 2	1
5	Matting agent	8
6	Micronised wax	3
7	Modified wax-dispersion	2.5
8	Urea -thickener	0.4
Total		100



Features/Benefits:
- Synthetic phyllosilicate allows controlled restructure on the substrate
- Allowing for improved pigment spacing
- Improved warming effect
- Flexibility in formulation

Control, no phyllosilicate - sedimentation

0.5%a.s Phyllosilicate No Sedimentation

Matting – stabilisation of renewable-based PU formulation
General formulation

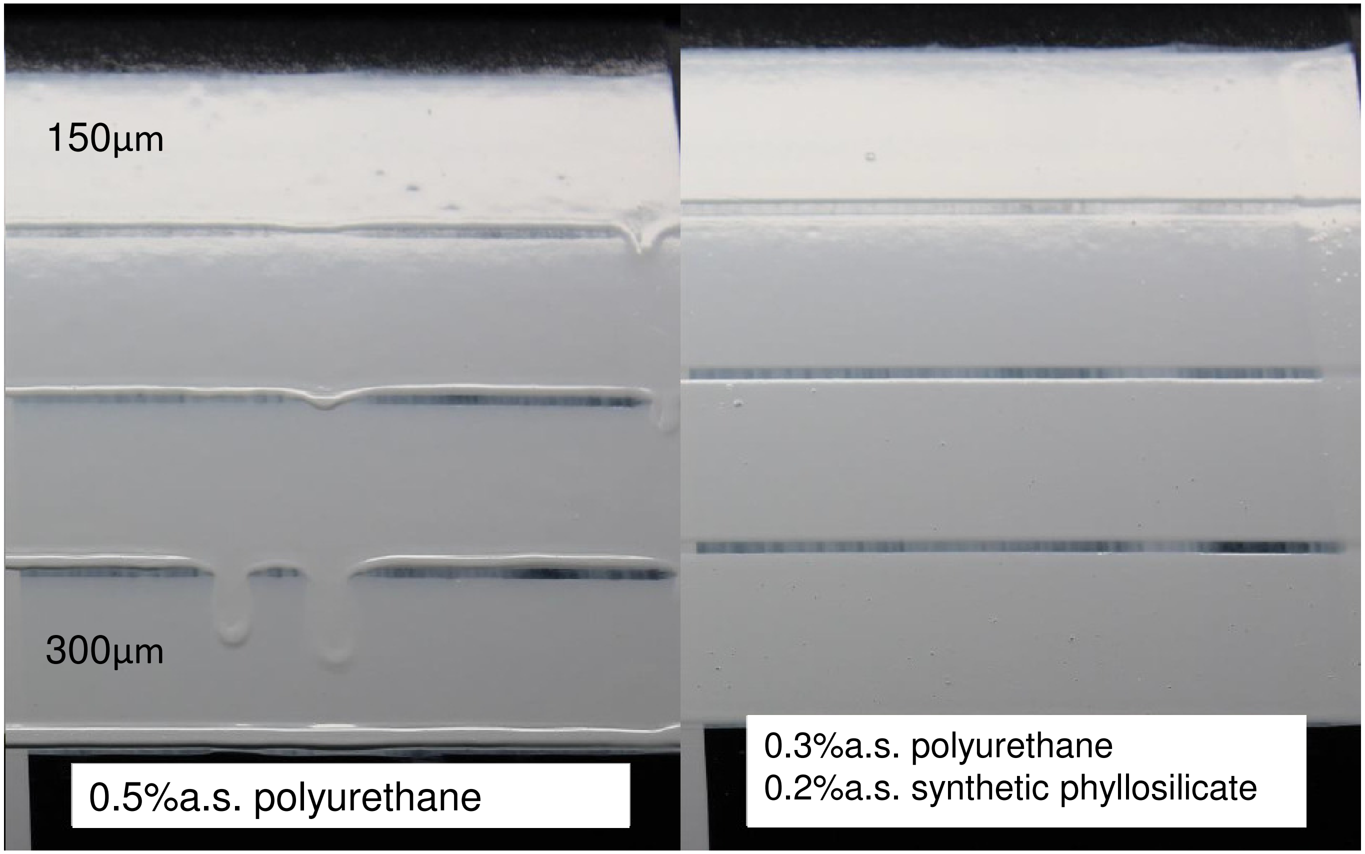
Position	Function	Weight [%]
1	Renewable-based PU	74.5
2	Defoamer	0.3
3	Defoamer 2	0.3
4	PU thickener	1.2
5	Biodegradable micronized wax-like polymer	2.5
6	Micronised PE wax	2.5
7	Glycol ether	0.5
8	Solution of sol grade synthetic phyllosilicate (25% solids)	2
Total		100

Features/Benefits:
- Synthetic phyllosilicate allows controlled restructure on the substrate
- Allowing for improved pigment spacing
- Improved warming effect
- Flexibility in formulation of sol grades where water availability is limited

Control, no phyllosilicate - sedimentation

0.5%a.s Phyllosilicate No Sedimentation

Improvement in anti-sag
Synthetic phyllosilicates 🤝 Polyurethanes



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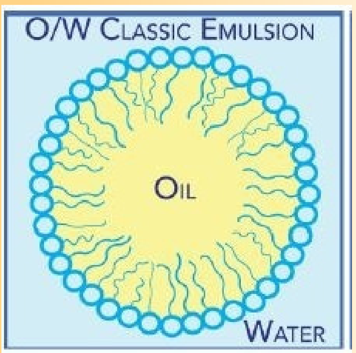
It’s not all about Rheology…

Pickering Emulsions
What are Pickering emulsions

- Professor Walter Ramsden (1903) and Prof. Spencer U. **Pickering** (1907) identified that small particles could act as emulsification agents in a similar way to classical surfactants.

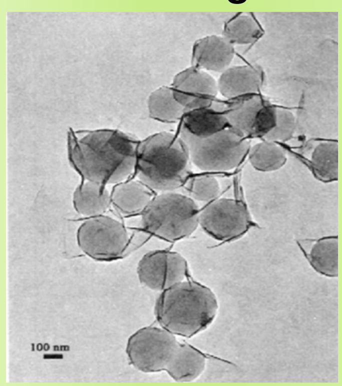
Surfactants are most commonly used as emulsion stabilizers



Surfactant-based emulsifiers tend to form small droplets, nm to µm

Particles (nm to µm) can adsorb at interfaces to stabilize oil or water droplets

→ **Pickering Emulsions:**



TEM of 2% montmorillonite stabilized monolinolein/styrene emulsion in water

- Particles of intermediate hydrophobicity / hydrophilicity are best for stability
- Wide range of droplet sizes possible; nm to mm

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Pickering Emulsions
Preparing a Synthetic Clay O/W emulsion

1. **Synthetic clay** powder is added to the water, followed by the oil phase

2. The sample is homogenized using a high-shear mixer

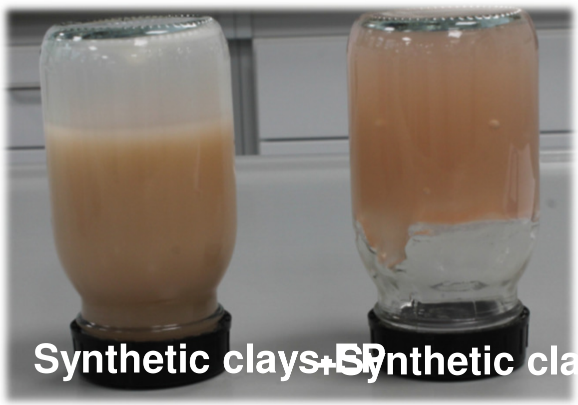
3. After 15 minutes emulsification is complete, with the resultant oil-in-water emulsion stabilized by the solid **Synthetic clay** particles only.

Pickering Emulsions
Case studies – perfume oil emulsion and tire shine formulation

Perfume Oil Emulsion

Ingredients:

78.75 % Demineralized water
0.05 % Sodium chloride (NaCl)
1.20 % Synthetic clay
20.00 % Perfume Oil - Fragrance



Tire Shine

Ingredients:

78.75 % Demineralized water
0.05 % Sodium chloride (NaCl)
1.20 % Synthetic clay
20.00 % Surface additive based on silicone

Anti-Static cleaners
Theory

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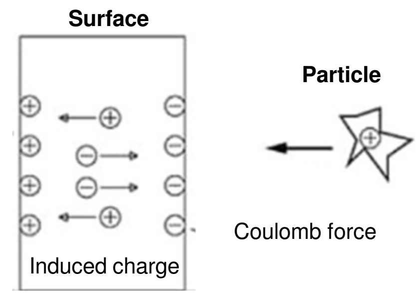
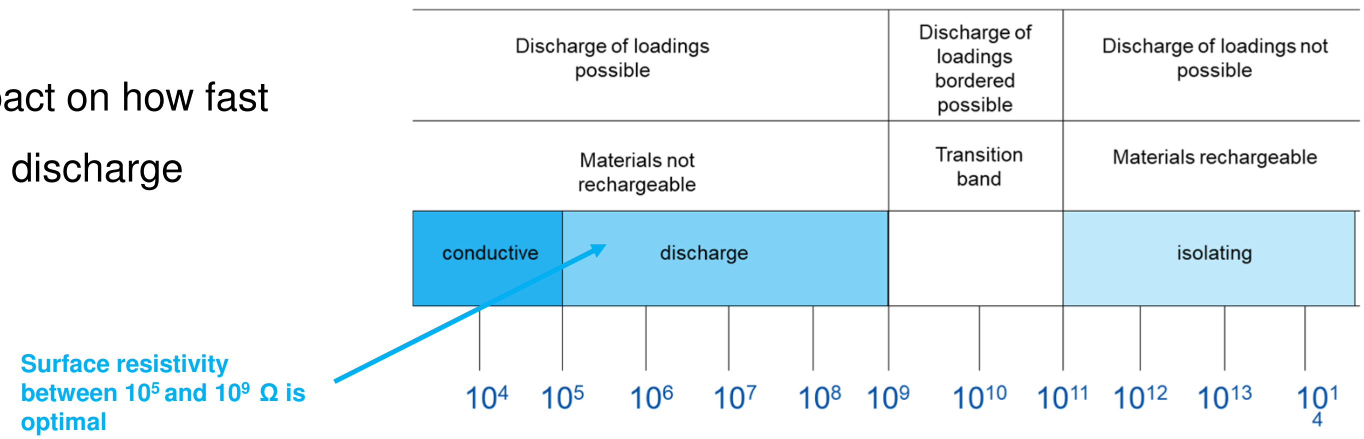
- a lot of surfaces (plastic, glass...) possesses electrostatic charges, that attracts dirt particles
- Anti-static cleaners counteract electrostatic charging and therefore prevent dust deposition
- The resistivity has an impact on how fast electrostatic loadings can discharge





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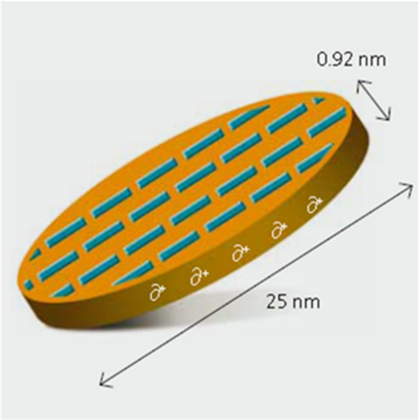
Anti-Static cleaners
Synthetic clays as anti-static agent

- All Synthetic clays types are electrically conductive and can be used to develop antistatic effects
- When coated onto a substrate, synthetic clay conducts electricity
- The charge distribution of synthetic clay enables efficient dissipation of static charge.
- Depending upon dosage levels, synthetic clay can be used to produce a surface resistivity in the range **10^6–10^{12}** ohms/square.



Single LAPONITE Crystal

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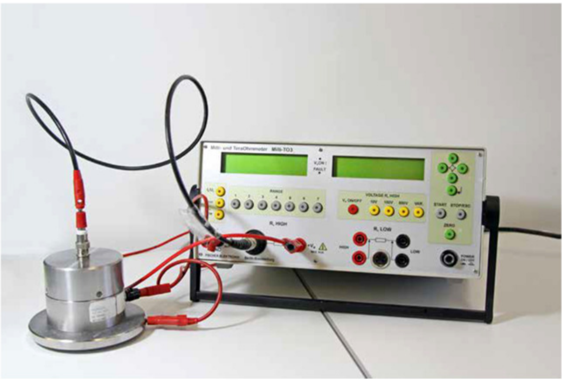
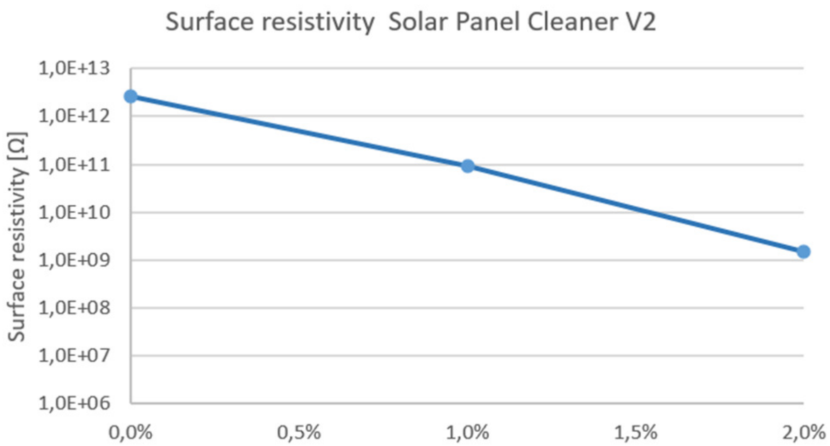
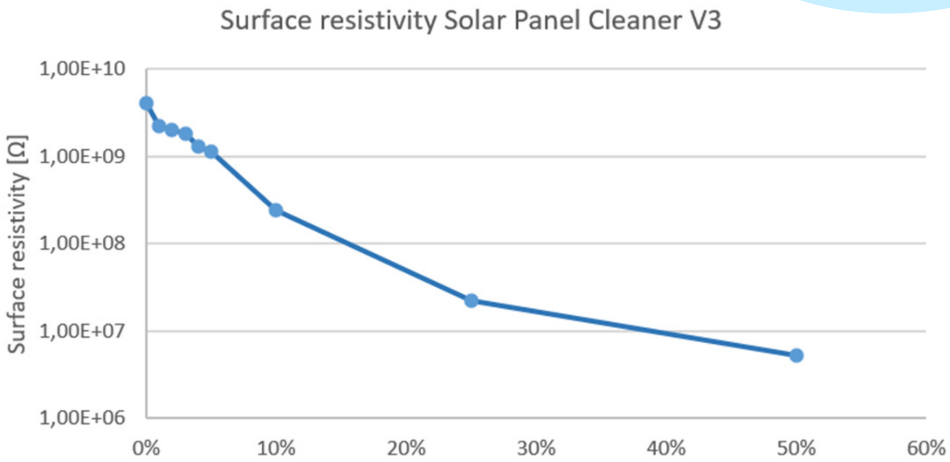
Anti-Static cleaners
Synthetic clays as anti-static agent - examples



	Surface resistivity [Ω]	
	Without additive	**5 % synthetic clay solution**
Commercial cleaner	$6.9 * 10^{12}$	$1.7 * 10^{9}$

Synthetic clay reduces the resistivity, to obtain anti-static effect





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Thank you for you attention

Time for Questions!

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