

Polymeric flow and levelling additives for water borne coatings

No more aspect ups and downs by mastering levelling

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It is without saying that water borne coatings will continue to grow and step by step will replace all solvent based paints and coatings.

Whether it is about industrial or decorative coatings, water borne finishes need to get a perfect surface appearance and optimal mechanical properties.

During the drying of water borne coatings, some irregularities or marked textures can arise on surface finish. It leads to surface coatings defects such as craters, waving, orange peels aspects, pinholes...

But a perfect surface aspect derives from a good substrate wetting, perfect flow and good levelling properties of the liquid coatings.

Leveling

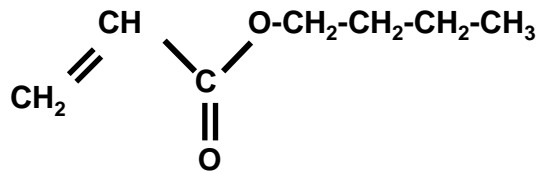
The best leveling is the achievement of the lowest surface area possible

- The additive must have a relatively high surface tension
- Localized homogeneity of the surface tension at the coating / air interface
- Absence of “Surface Waviness”

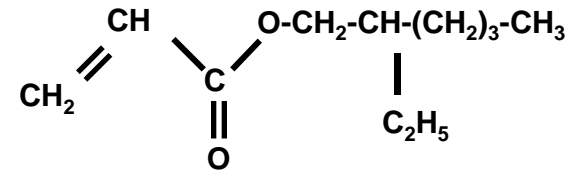
Mainly provided by copolymers based several acrylic monomers structure with different monomers ratio used, polymer structures (linear, branched,..), molecular weight and organic modification.

Substrate wetting, Flow and Leveling

Polyacrylate Products



n- Butyl-acrylate



2-ethylhexyl acrylate

Example of monomers used for Homopolymers or Copolymers

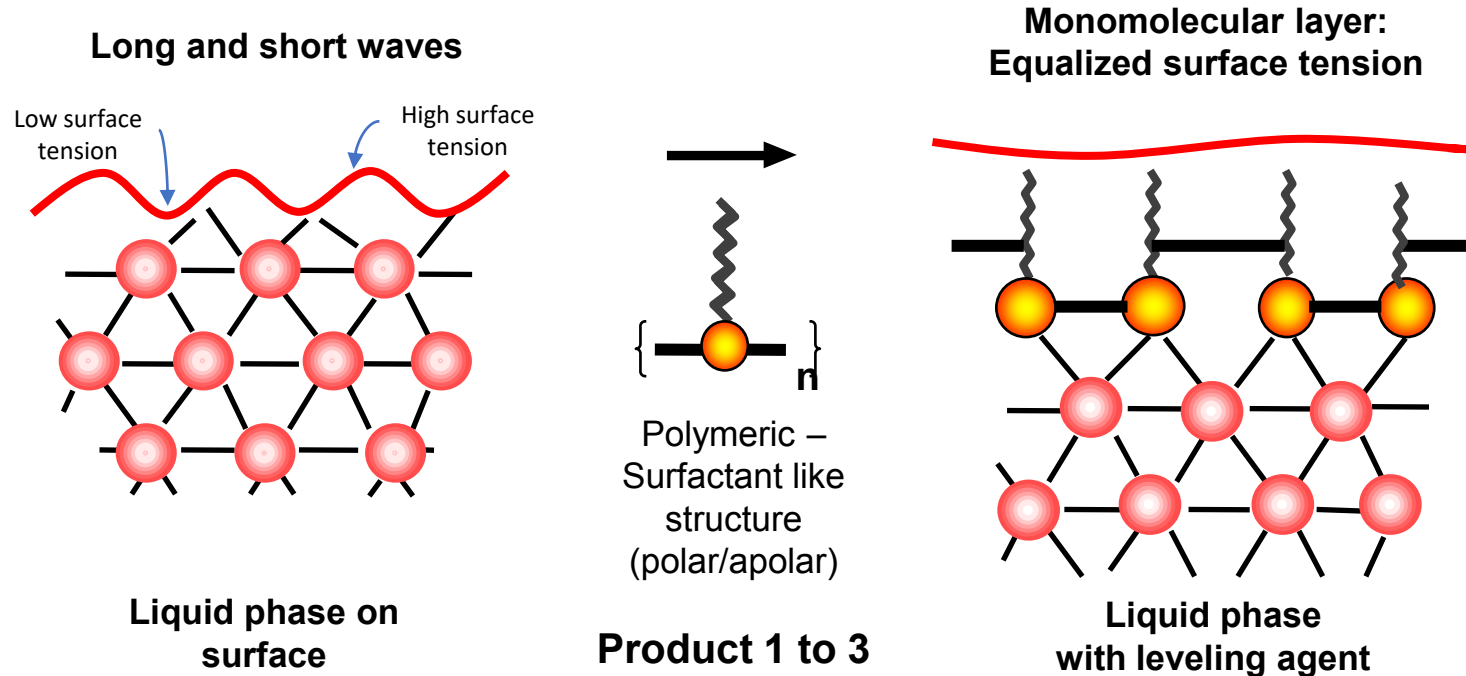
Advantages

- ✓ higher surface tension than polysiloxane (better intercoat adhesion)
- ✓ Better compatibility than polysiloxane

Inconvenient

- ✓ Incompatibility may lead to haze and loss of gloss and DOI
- ✓ May decrease the surface hardness in case of low molecular weight

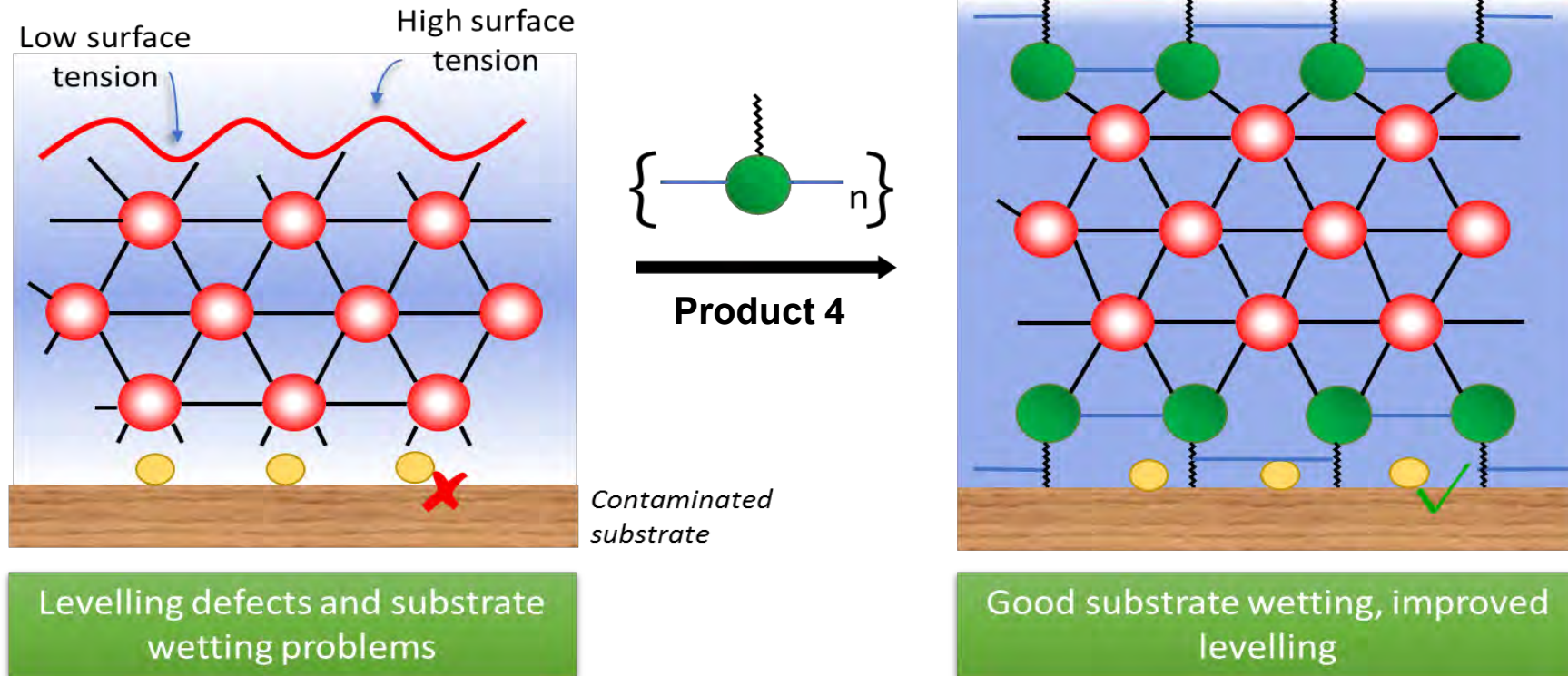
Levelling: Working action



Polymeric leveling agents will be oriented at the liquid / air interface. Equalizing the surface tension, they reduce significantly the short waves and as a consequence improves the leveling.

Additives with medium surface tension

Levelling and substrates wetting: Working action



A gradient of additive is oriented at the liquid / air, equalizes the surface tension and reduces significantly the short waves and as a consequence improves the leveling.

The part of additive oriented at the liquid / solid interface, reduces the surface tension and helps to wet properly the substrate, even contaminated.
(Additive with low surface tension)

Silicone-free polymeric levelling agents characteristics

They bring important properties in coatings

- ✓ Orange peel
- ✓ DOI
- ✓ Ghosting effect
- ✓ Clouding of metallic coatings
- ✓ Fish eyes, craters, pin holes
- ✓ Edge crawling
- ✓ Not affect intercoat adhesion (higher surface energy than polydimethylsiloxane)

They do not

- ✓ Improve slip effect
- ✓ Increase mar and scratch resistance

Products range of flow and levelling agents for water borne systems:

- Product 1** VOC-free & Silicone-free polymeric levelling agent
- Product 2** VOC-free & Silicone-free polymeric levelling agent – lower viscosity
- Product 3** VOC-free & Silicone-free polymeric levelling agent – Higher open time
- Product 4** VOC-free polymer polysiloxane modified wetting substrate and levelling

Those “Products” are copolymers based on several acrylic monomers with different monomers ratio, polymeric structure (linear, branched,..), molecular weight and eventual organic modifications.

Basic data of levelling polymeric additives for water borne coatings

	Product 1	Product 2	Product 3	Product 4
Chemistry	VOC-free neutralized acrylic terpolymer	VOC-free neutralized acrylic terpolymer	VOC-free neutralized acrylic terpolymer	VOC-free neutralized modified polysiloxane acrylic terpolymer
Active content	48 %	31 %	48 %	52 %
Recommended dosage	0,5 to 3,0 %	0,8 to 3,5 %	0,5 to 3,0 % (up to 5%)	1,0 to 3,0 %
Solvent	Water	Water	Water	Water
Viscosity	30 000 mPa.s	< 1 500 mPa.s	25 000 mPa.s	9 000 mPa.s
Surface tension @ 1% in water (dynes/cm)	45 Dynes	45 Dynes	46 Dynes	24 Dynes
Aspect and Colour	Clear to opalescent Pale yellow	Clear to opalescent Pale yellow	Clear, Pale yellow	Clear, pale yellow
Main action & specificity	Flow & Levelling No foam stabilisation	Flow & Levelling Low viscosity for easy handling	Flow & Levelling Open time extender	Substrates wetting and Flow / Levelling properties

Besides the **flow and levelling properties**, we can benefit of **positive side-effects** due to their chemical structure such as:

- **Coalescing properties**: Can replace co-solvents and wetting agents.
- **Open Time extension**: Improve the open time, and helps to decrease the level of coalescing agents.
- **Pigments wetting properties**: Can be also used a grinding resin for pigment concentrates in combination with a high molecular weight polymeric dispersing agent. Highest color strength.
- **Weathering resistances**: Because of the chemical structure, they do not affect the water resistance.
- **No loss of inter-coat adhesion**, ideal for primers and top coat



On positive side-effects, we can make evaluation:

- **Open time extension**
- **Wetting substrate performances**

Objective:

- Observe the impact of **Products 1 and 3** on drying time and open time in several water borne paints based on a Styrene-acrylic emulsion.
- The tests done help to compare the performances.

Open time and drying times are measured by using a drying time recorder (picture 1).

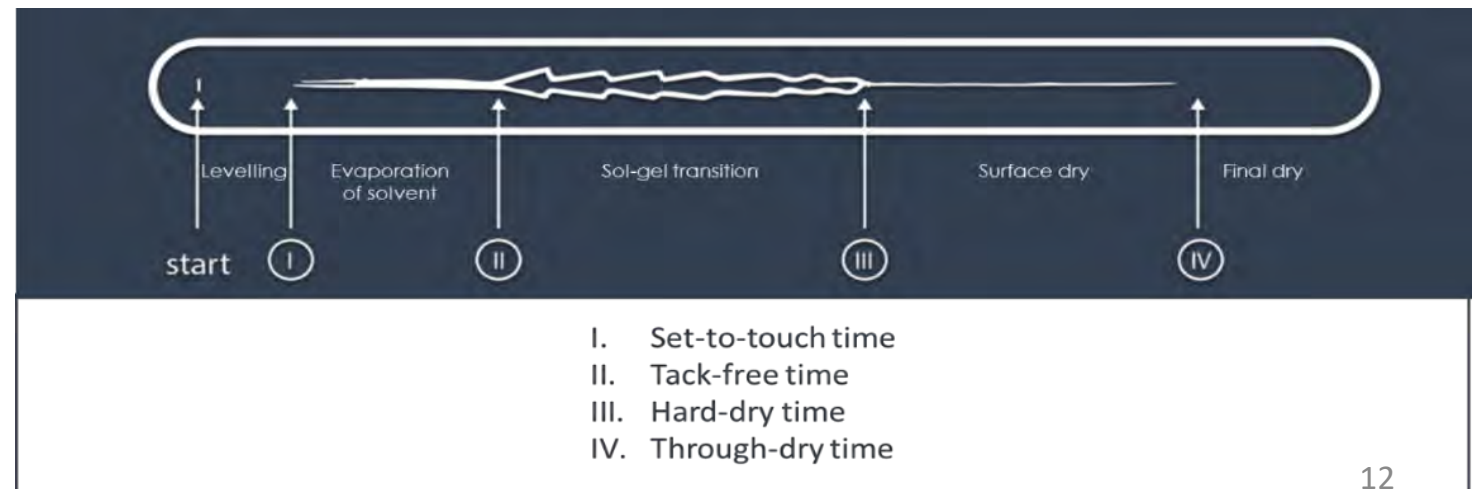
Drying time recorder

Paint or coating are applied on glass strips. Needles travel on these test tracks, over a selected time : 6, 12 or 24 hours (6 hours in our case). The drying time stages can be assessed as shown on following diagram.



Exemple of a drying time test measurement

Remark: In practice, all these stages are not always apparent. More often, we can easily observe the hard dry time (*which we call drying time*), and sometime the tack-free time (*which we relate to open time*).



Open time performances evaluation

Formulation of a white mat paint based on styrene-acrylic emulsion

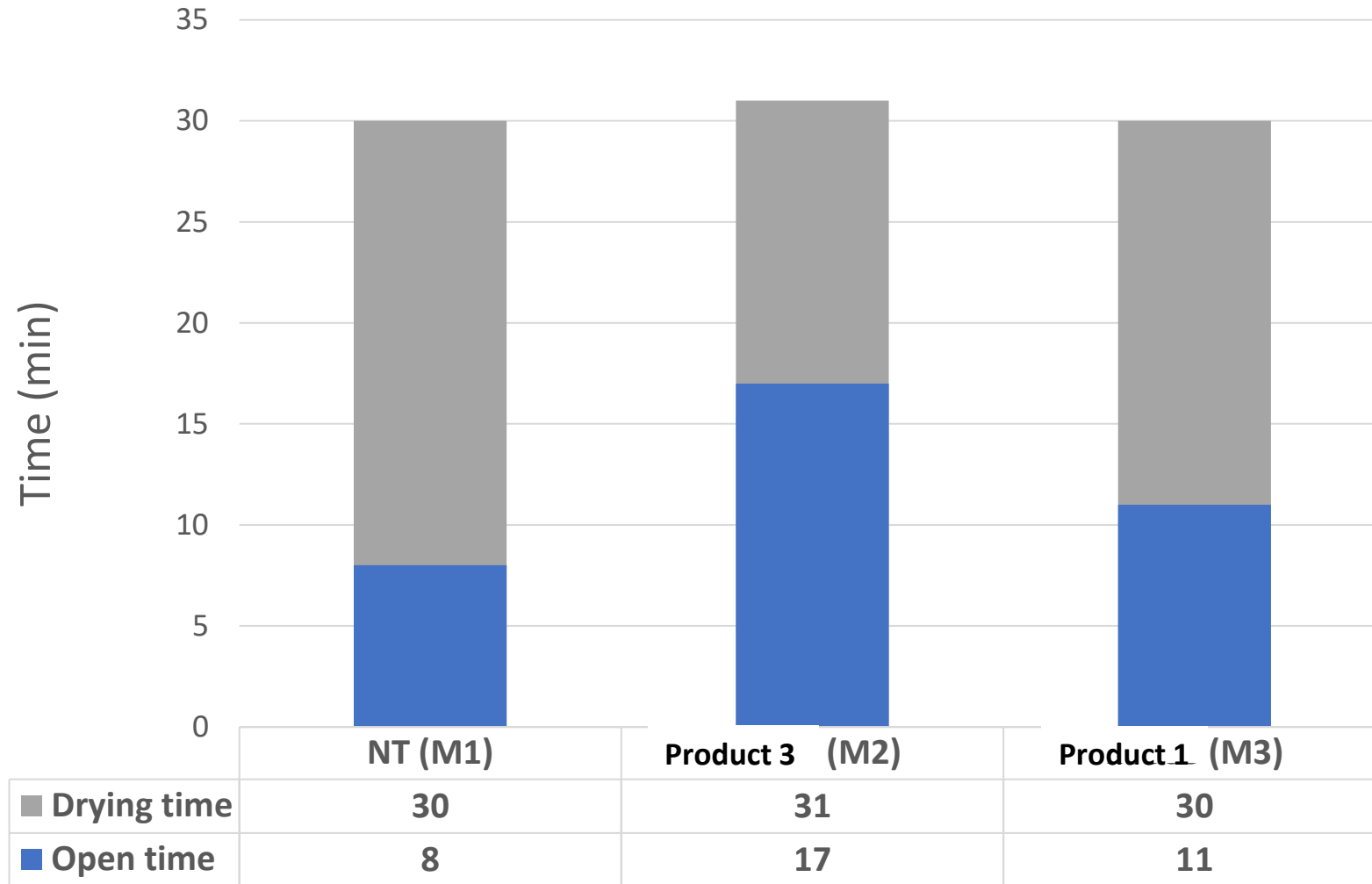
Matt white Paint Base (Base M)		
Raw Materials	Description	Parts by weight
Styrene-acrylic emulsion	Styrene-Acrylic binder - 40% solid in water	34,0
TiO2	TiO2 pigment	14,0
Luzenac 20M00S	Talc	3,0
Durcal 5	CaCO ₃	21,2
Wetting / dispersing agent	Dispersing agent	1,9
Defoamer	Defoamer	0,4
Thixotropic agent	Non associative Thickener (ASE)	1,4
Water		23,5
pH buffer	pH neutralizer	0,3
Biocide		0,3
Sum		100,0

Open time performances evaluation

Mat paint							
		Base Paint With coalescing agent			Base Paint Without coalescing agent		
Test n°		M1	M2	M3	M4	M5	M6
Base paint	Mat paint	100,0	100,0	100,0	100,0	100,0	100,0
DPnB	Coalescing agent	2,5	2,5	2,5			
Product 1	Leveling agent			2,5			2,5
Product 3	Leveling agent		2,5			2,5	
Total		102,5	105,0	105,0	100,0	102,5	102,5

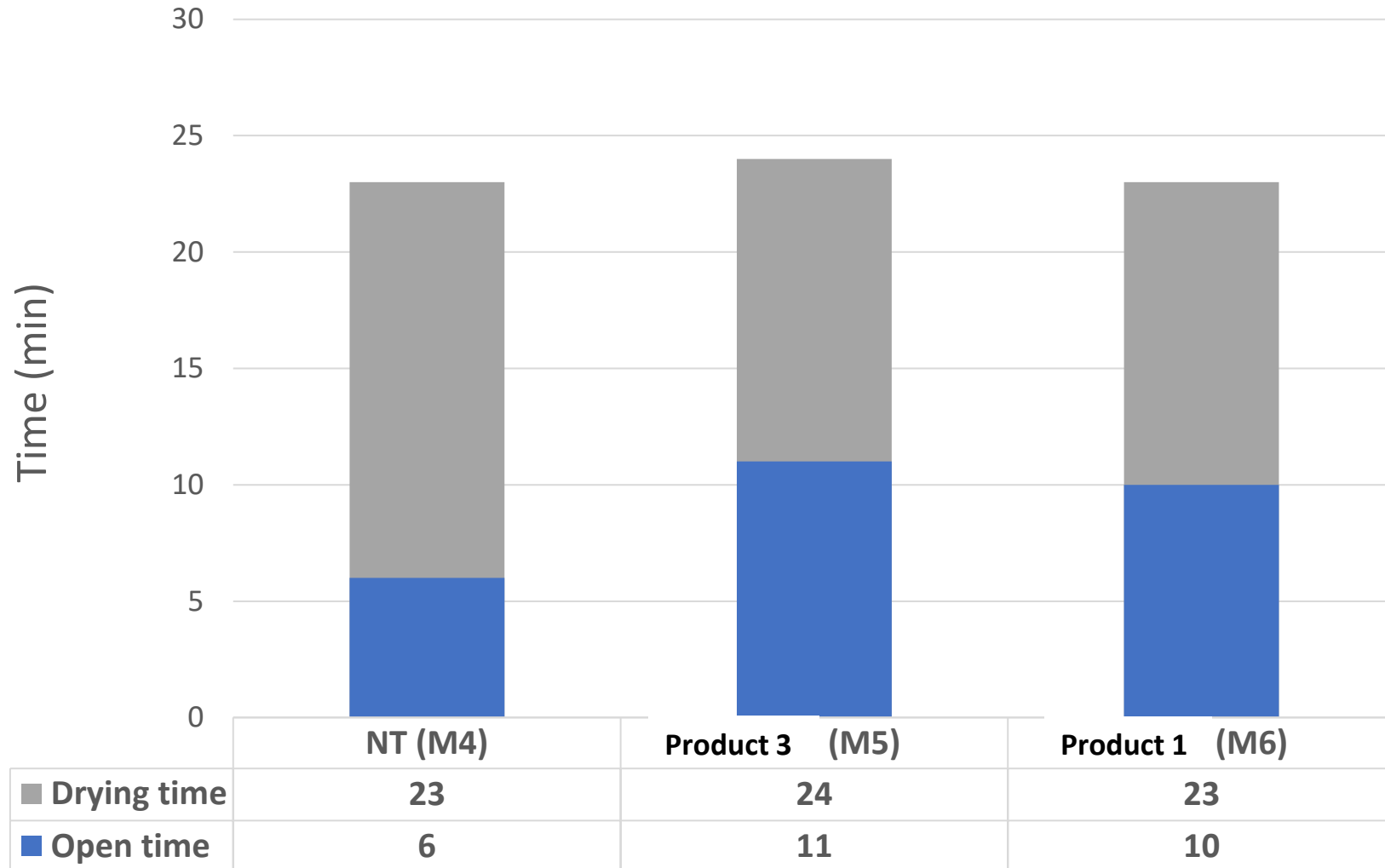
Open time performances evaluation

With coalescing agent – Dipropylene Glycol n-Butyl ether



Open time performances evaluation

Without coalescing agent



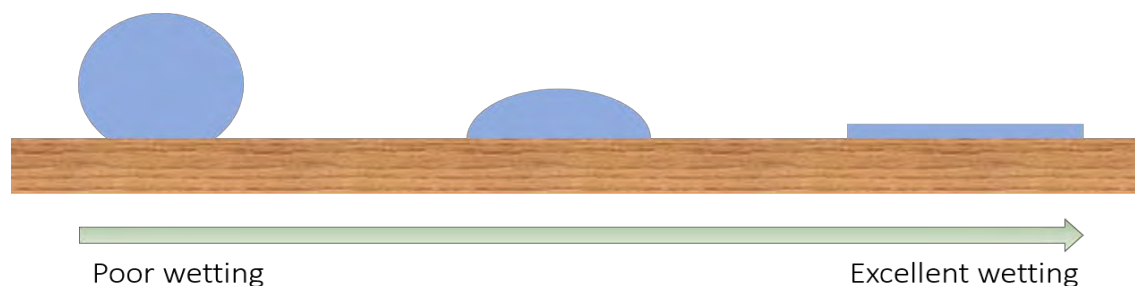


On the positives side-effect, we can make evaluation of:

- Open time extension
- **Wetting on contaminated substrate**

Our actual products range provide performances on wetting substrate and levelling to the coatings. Very often to get both performances it is needed to use 2 different additives:

1 for wetting substrate



and 1 for flow and levelling.



Product 4, based on polyacrylate copolymer polysiloxane modified, associates substrate wetting performances with flow and levelling. It is a strong advantage for all formulators which do not want to add numbers of additives in their formulation, and strong costs saving also.

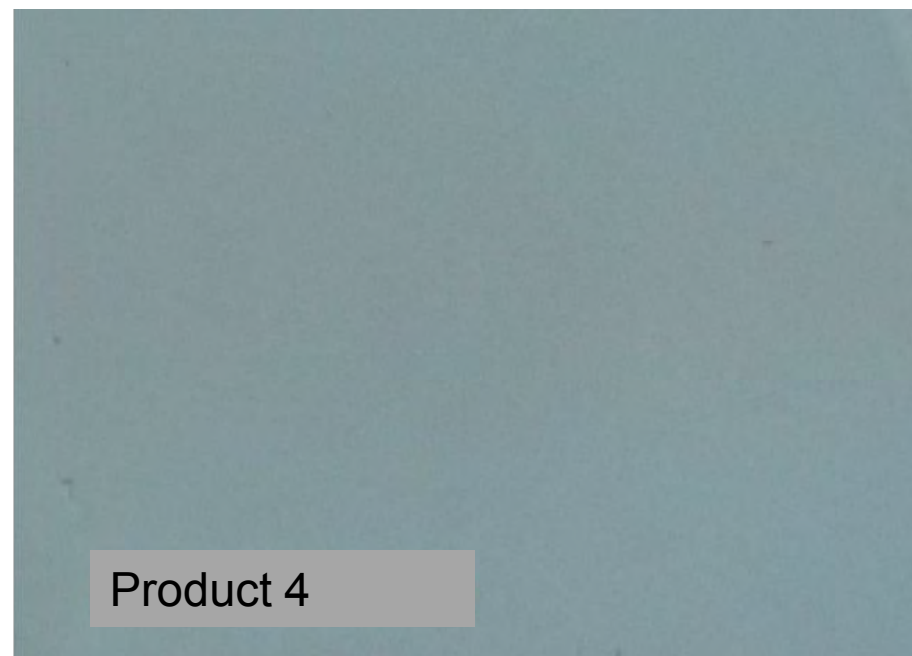
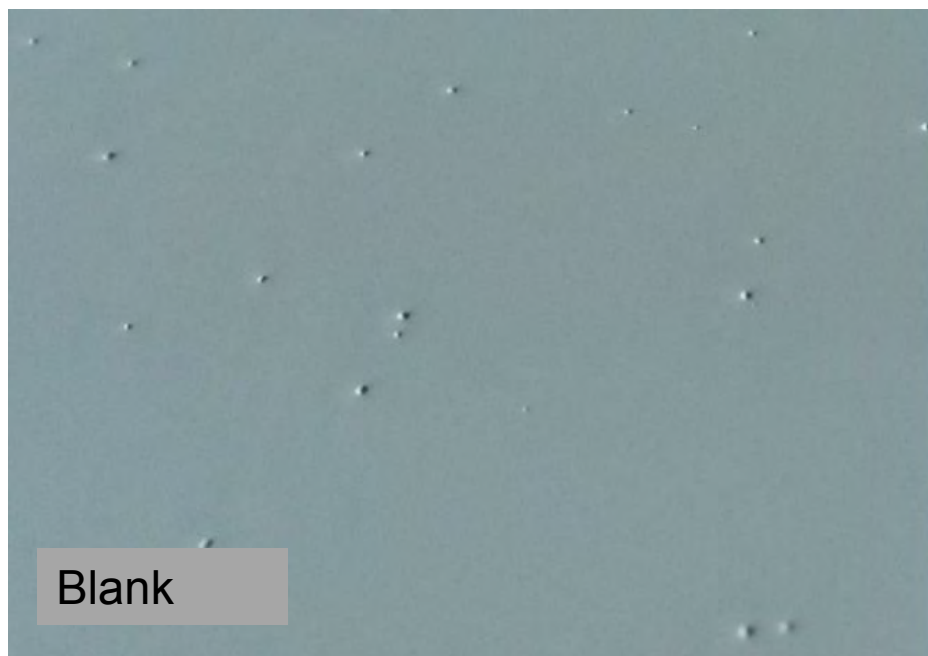
Flow and levelling performances evaluation

Evaluation with 2 types of white paints

Paint A - based on polyester-polyurethane dispersion			Paint B – based on Polyurethane dispersion		
Raw Materials	Description	Parts by weight (%)	Raw Materials	Description	Parts by weight (%)
Water		7,3	Water		15,3
Thixo Agent	Associative thickener (HASE)	1,3	Thixo agent	Associative thickener (HASE)	0,8
Binder	PES/PUD	56,7	Binder	Polyurethane dispersion	50,0
White concentrate	Based on TiO ₂ (70%) and Polymeric dispersing agent	26,5	White concentrate	Based on TiO ₂ (70%) and Polymeric dispersing agent	29,8
Dispersant	Polymeric Dispersing agent	0,6	Dispersant	Polymeric Dispersing agent	0,2
Luzenac 20 MOOS	Talc	2,4	Luzenac 20 MOOS	Talc	0,6
Durcal 5	CaCO ₃	4,0	Durcal 5	CaCO ₃	2,1
Defoamer	Polysiloxane emulsion	0,2	Defoamer	Polysiloxane emulsion	0,4
Thixo agent	Non associative Thickener (ASE)	0,4	Thixo Agent	Non associative Thickener (ASE)	0,6
DMEA	pH neutralizer	0,6	DMEA	pH neutralizer	0,2
Total		100,0	Total		100,0

Flow and levelling performances evaluation

Product 4: Evaluation of levelling effect



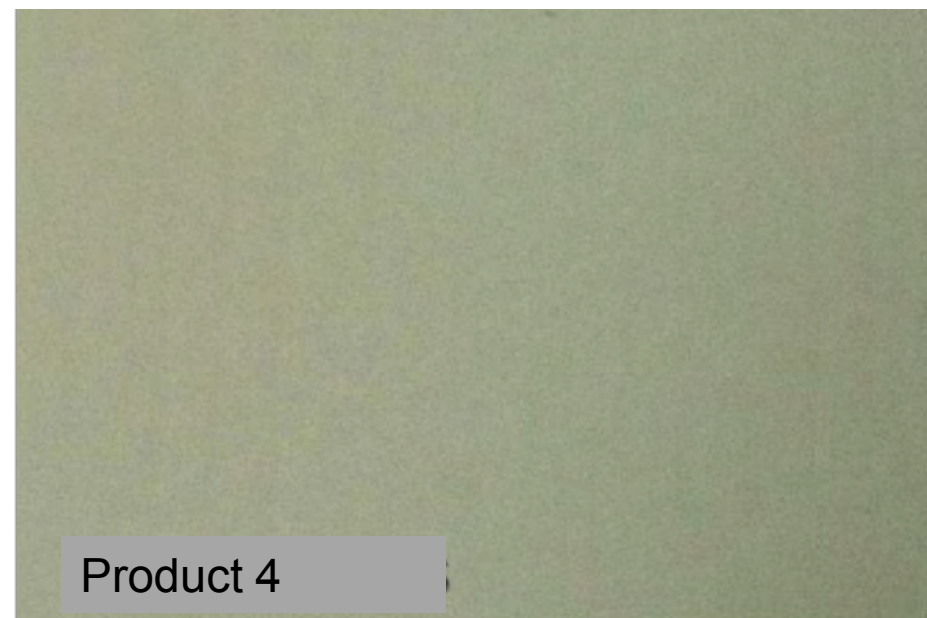
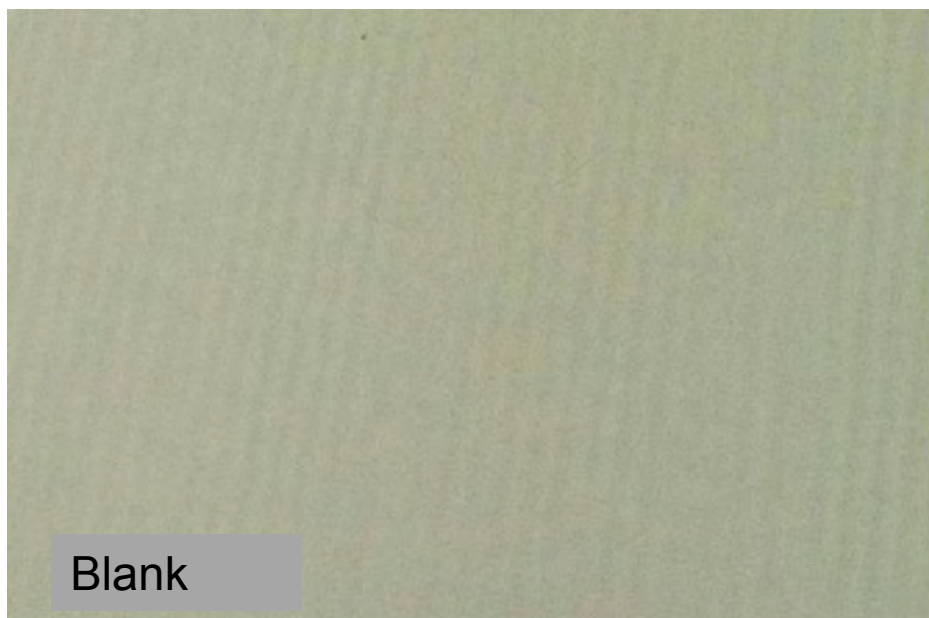
Paint A: Application, laboratory conditions:

- ***On glass panel***
- *K-Coater application, thickness 100 μm (wet)*
- *Ambient drying (23°C)*

Product 4 improves the surface appearance of coatings. Picture shows a significant improvement of cratering and popping when it is used in the paint A.

Flow and levelling performances evaluation

Product 4: Evaluation of levelling effect



Paint A: Application, laboratory conditions:

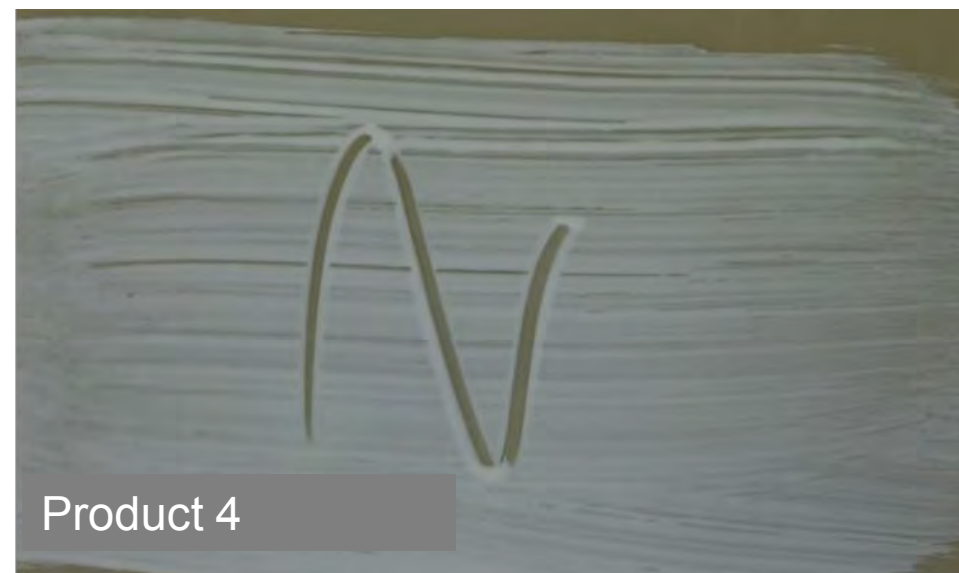
- ***On glass panel***
- *K-Coater application, thickness 100 μm (wet)*
- *Ambient drying (23°C)*

Product 4 enhances flow and leveling.

It allows a significant attenuation of the applicator's marks when used in the paint B.

Flow and levelling performances evaluation

Product 4: Evaluation of Substrate wetting effect



Paint A: Application, laboratory conditions:

On degreased polypropylene panel (Surface energy $\approx 30 \text{ dynes.cm}^{-1}$ No specific surface treatment have been proceeded.). Brush application (wet and squeezed). When the paint is just applied, a mark is made using a wooden stick.

This helps to observe an eventual de-wetting effect (crawling effect or paint retraction) on the coating film edges.

Paint without additive, shows an important de-wetting. It doesn't recover properly the substrate (Crawling effect)

Paint with **Product 4** doesn't retract and wet perfectly the substrate.

Product 4 – performances summary

- ✓ Improves substrate wetting
- ✓ Reduces edge crawling

- ✓ Improves orange peel
- ✓ Improves DOI
- ✓ Reduces fish-eyes, craters, pin-holes

- ✓ No negative impact on gloss and rheology
- ✓ No negative impact on the inter-coat adhesion

- ✓ “2 in 1” additive

POLYMERIC FLOW AND LEVELLING ADDITIVES FOR WATER BORNE COATINGS



Products 1 to 4: Selection table of efficiency on usual water borne paints based on:

- Acrylic and styrene-acrylic based emulsion
- Polyurethane dispersion
- Hydro-reducible polyester and alkyd resins

Product 1: Modarez PW 336
 Product 2: Modarez FA 365
 Product 3: Modarez PW 363
 Product 4: Modarez PW 677

PRODUCTS	Wetting substrate	« anti-silicone » effect	Flow	Levelling	Gloss	Extending Open time	Coalescing effect	Degassing effect	Easy-to-handle
Product 1	+	0	+++	+++	++	++	+++	++	+
Product 2	+	0	+++	+++	++	++	+++	++	+++
Product 3	+	0	+++	+++	++	+++	+++	++	++
Product 4	+++	++	+++	+++	++	+	++	+	+++

Polymeric Flow and Levelling Agent for water borne coatings: Performances summary

- ✓ Improve the flow and levelling
- ✓ Improve substrate wetting
- ✓ Reduce edge crawling

- ✓ Prevent orange peel
- ✓ Improve DOI
- ✓ Reduce fish-eyes, craters, pin-holes

- ✓ Improve wetting pigment

- ✓ VOC-free
- ✓ Coalescing effect help

- ✓ No negative impact on gloss and rheology
- ✓ No negative impact on the inter-coat adhesion

Thanks for your attention

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