Multifunctional nano-polymers emulsions for wood coatings

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AGENDA

Vinavil introduction

Nano-tech against conventional polymers

Functionalization and crosslinking agents

Acrylics for wood coatings

Summary

VINAVIL POLYMERS

- PVAc Polyvinyl Acetate
- VA/VEOVA Vinyl Acetate/Vinyl Versatate
- VA/A Vinyl Acetate/Acrylate
- VA/E Vinyl Acetate/Ethylene
- VA/DBM Vinyl Acetate/Dibutyl Maleate
- A Acrylics
- S/A Styrene/Acrylic

in dispersion, powder, beads and pastilles

VINAVIL
Global Reach Local Focus

Where Vinavil polymers are present?

Coatings

Adhesives

Building

Textile

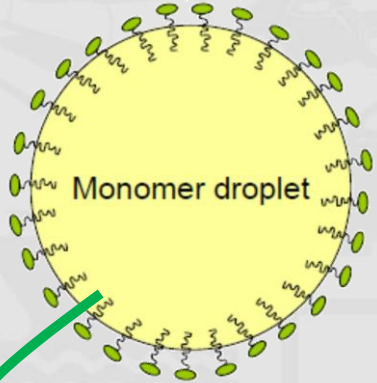
Specialties

Design a polymer

- Polymerization technologies
- Particles size distribution
- Morphology
- Functionality
- Crosslinking
- Tg and MFFT

Emulsion Polymerization

Mechanism



Monomer diffuses from droplets (>500 µm) into surfactant micelles where the polymer grows.

Growing polymer particles

Surfactant micelles

Polymer particle

Number of particles

Radicals' generation rate

Total surfactant

$$N_p \propto \left(\frac{R_I}{r_v}\right)^{0.4} (a_S S_T)^{0.6}$$

Volumetric growth rate

Polymer surface covered by 1 mol of surfactant

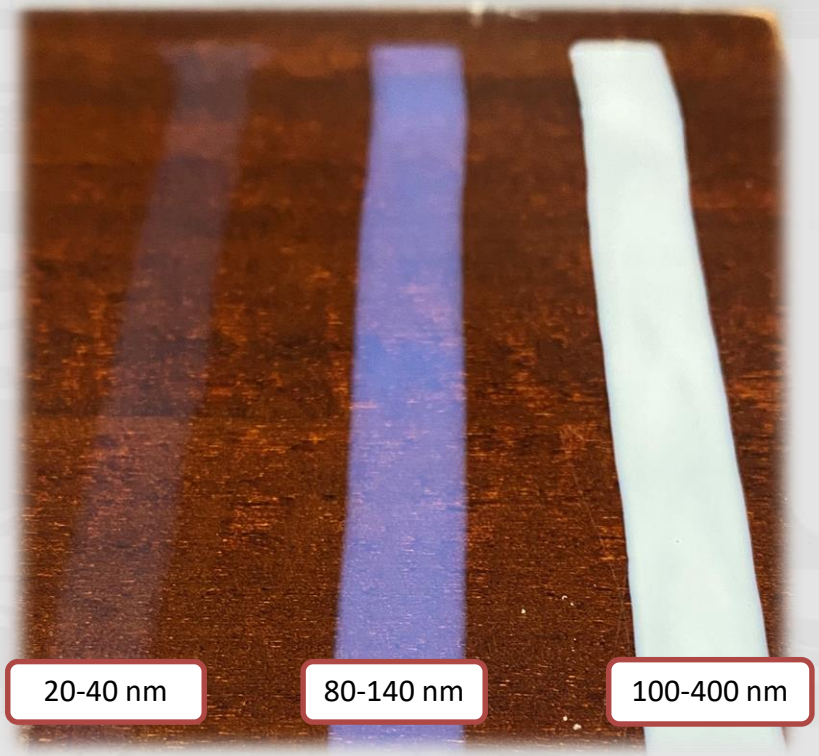
With the same technology is possible, varying:

- Initiator's quantity and type
- Surfactant concentration

Obtain

- Latex (particle size >40nm)
- Nanolatex (particle size <40nm)

Nano-technology vs conventional polymers

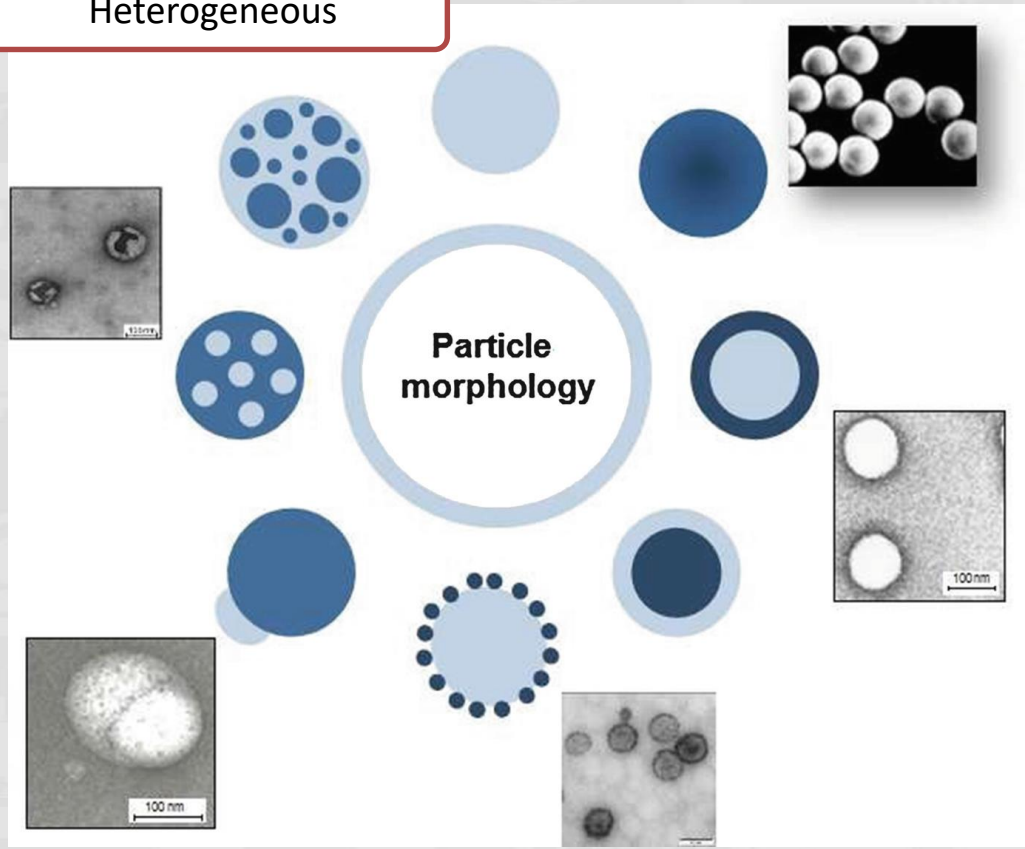


- Particles size < 100nm
- Transparency
- Easier film formation
- Higher penetration capacity
- High surface specific area
- High surface functionality

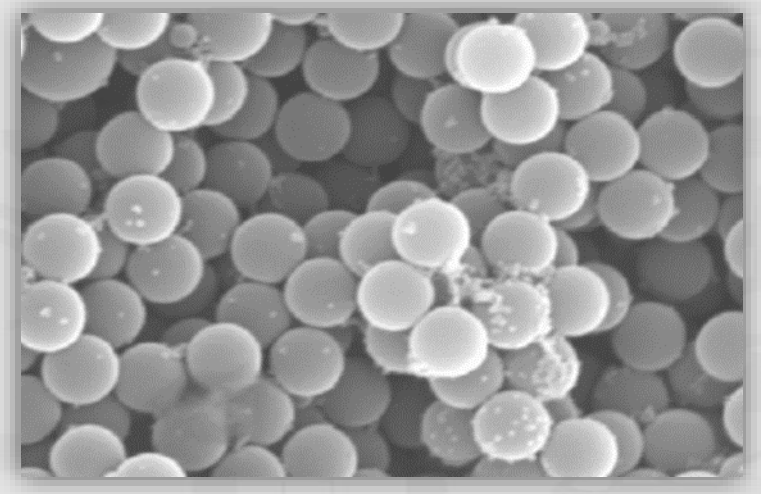
Vinavil Nano-latexes fall in 20-80 nm range

Morphology

Heterogeneous



Homogeneous

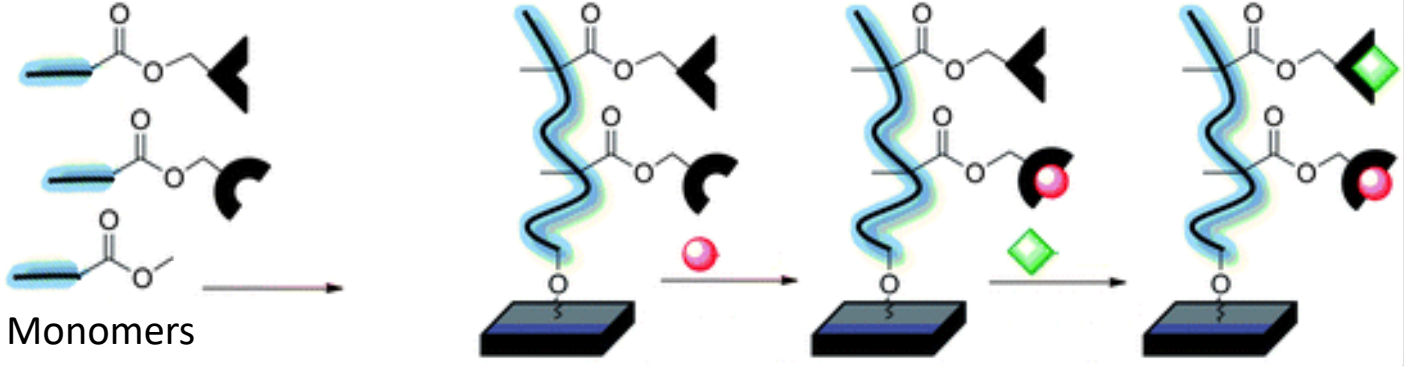


Functionalization

Functionalization allows to give special properties to the polymer, such as:

- Adhesion on metallic surfaces..
- Hydrophobicity or hydrophilicity
- Reactivity to specific substances
- Crosslinking

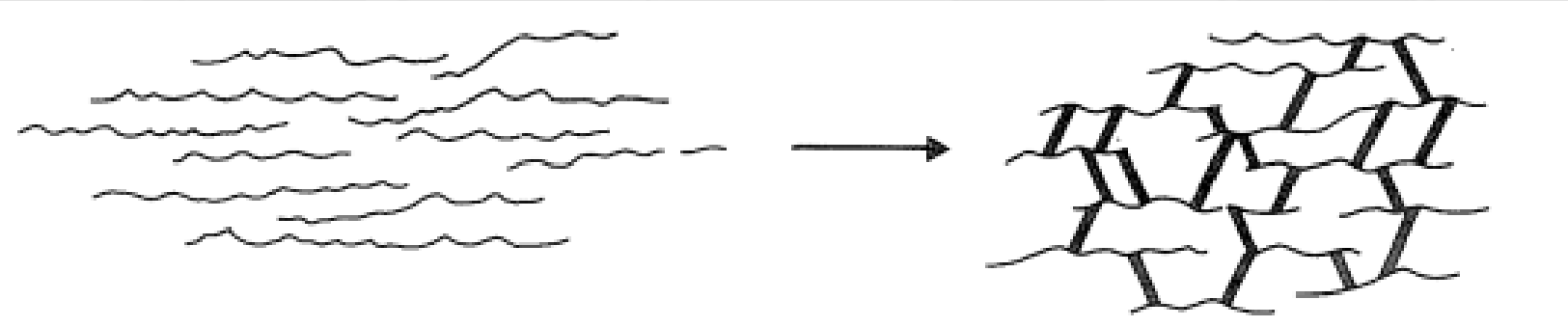
These properties are achieved by using at least one monomer with two (or more) functional groups.



Example of interaction with different substrates/molecules

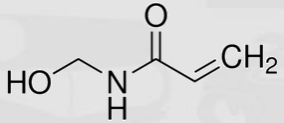
Crosslinking

Crosslinking is the formation of a polymer network, based on the reaction of functionality presents on the polymer chain, catalyzed by pH variations, UV light, heat or solvent/water evaporation. Crosslinking enhances mechanical properties, heat and water/solvent resistance etc..

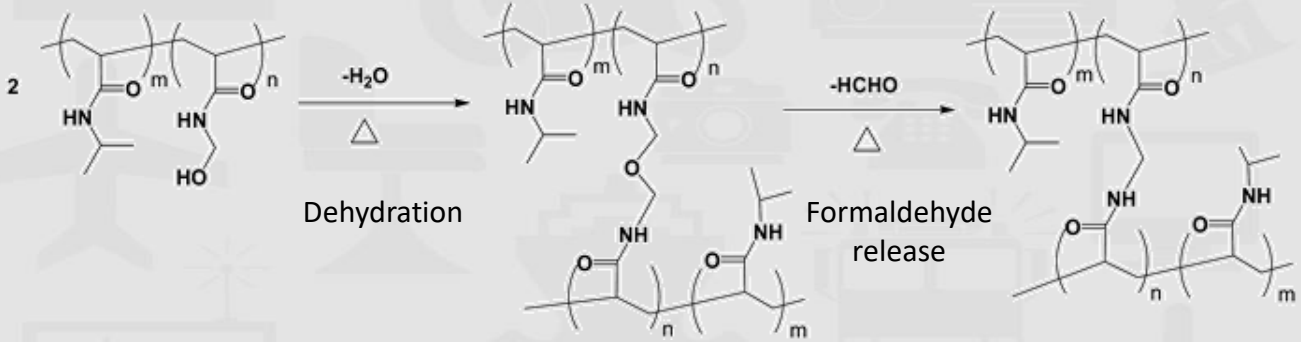


Crosslinking examples

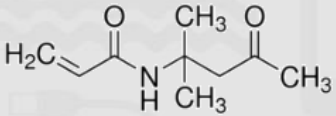
NMA system



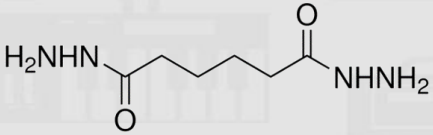
N-methylolacrylamide



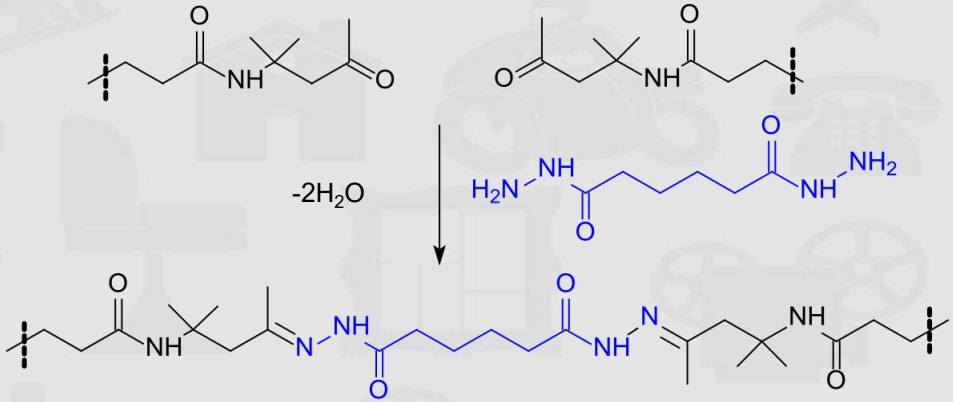
DAAM-ADH System



Diacetoneacrylamide



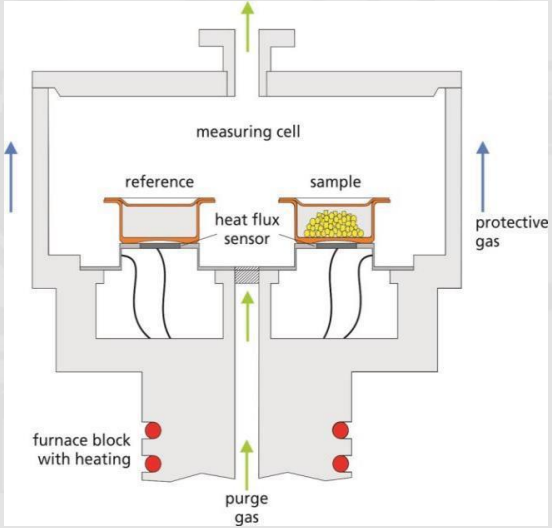
Adipic acid dihydrazide

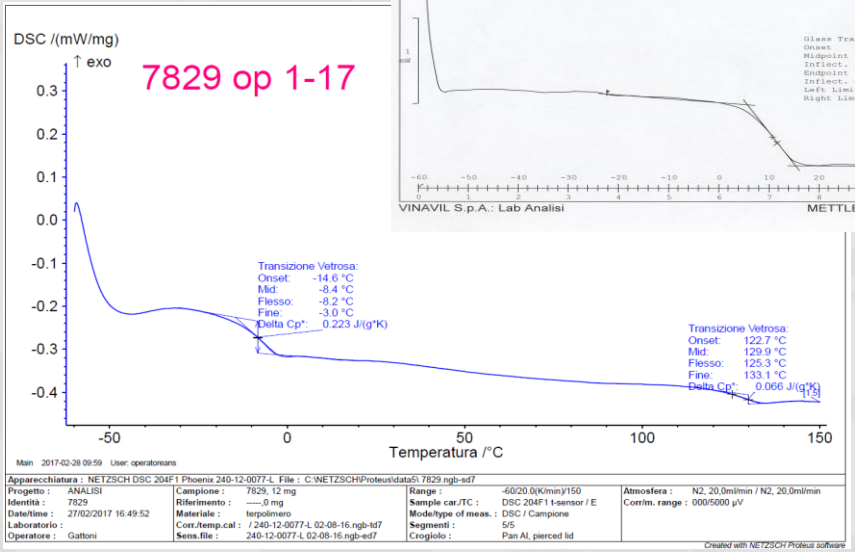


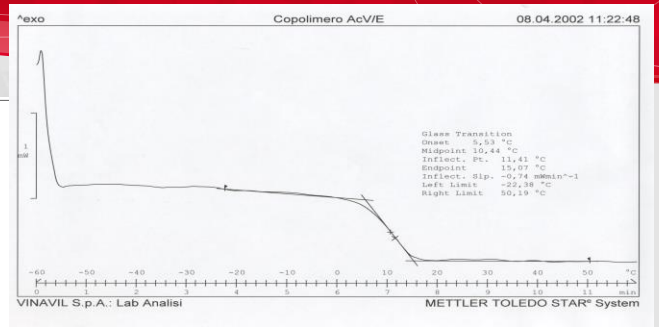
Tg: Glass Transition Temperature

Below the Tg the mobility of the polymer particles is strongly restricted. The polymer will be brittle.

DSC analysis







Low Tg

Stickiness

Plasticity, flexibility etc..

High Tg

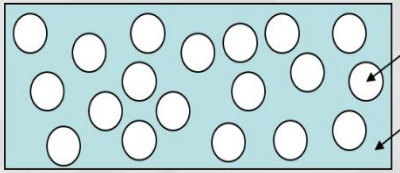
Stiffness, hardness

Scratch resistance etc..

Tg ≠ MFFT

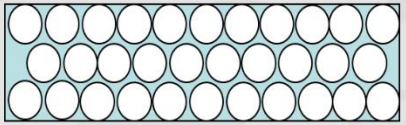
MFFT: Minimum Film Forming Temperature

Stage 1:
20 to 50 %
latex solids

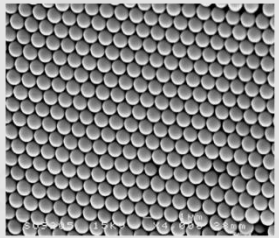


Water
evaporation

Stage 2:
Close contact
> 55 % solids

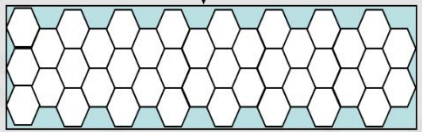


SEM image of
latex particles

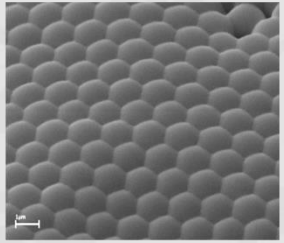


Particle
deformation

Stage 3:
Close-packed
deformed latex



SEM image of partially
film-formed latex



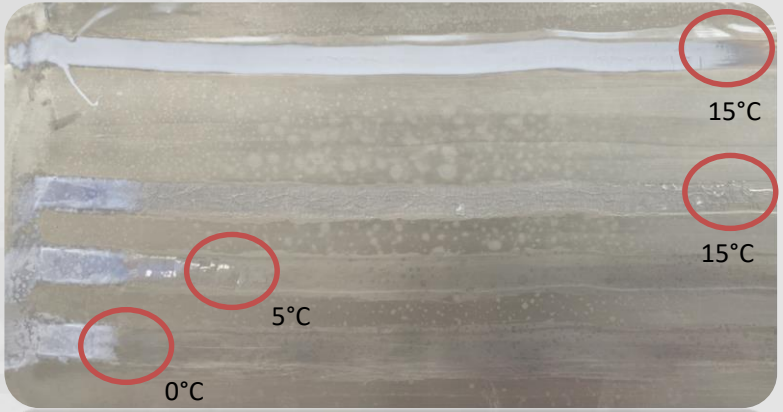
Hexagonal deformation

Further Film
Coalescence

T > MFFT

Stage 4:
Mechanically
coherent film

Complete loss of original
particle morphology



Polymer with MFFT>5°C needs coalescing agent for proper film forming at room temperature

Wood coatings in exterior applications

Features

- Weathering/UV resistance
- Water resistance
- Flexibility/elongation
- Block resistance
- Adhesion
- Rheological properties
- Aesthetic

Acrylics for exterior wood coatings

Enamel WB
glossy, satin
matt

Varnishes
clear,
pigmented

Impregnating

- Fine / nanometric particles
- Clear film
- Hardness
- Flexibility
- Block resistance
- Adhesion
- Water resistance
- UV / weathering resistance

Acrylics for exterior wood coatings

CHARACTERISTICS	Crilat 4815	Crilat 4830	Crilat 7829	Crilat 7832[new]
Note	Homogeneous Nanotechnology	Core-shell Self-crosslinking	Encapsulation Self-crosslinking	Encapsulation Self-crosslinking
VOC content (%)	<0,1	<0,1	<0,2	<0,2
Particles size distribution (nm)	25-40	60-120	20-60	20-60
Tg (°C)	+15	+15/+70 (*)	-5 / +130 (*)	-15 / +115 (*)
MFFT (°C)	5	10	10	0
Solid content (%)	31±1	46±1	44±1	44±1
Brookfield Viscosity (mPa.s)	<100	<1000	<300	<300
pH	7,0±1,0	9,0±0,5	8,0±0,5	8,0±0,5

(*) theoretical

Particles size distribution

Typical distribution of conventional acrylic

BECKMAN COULTER

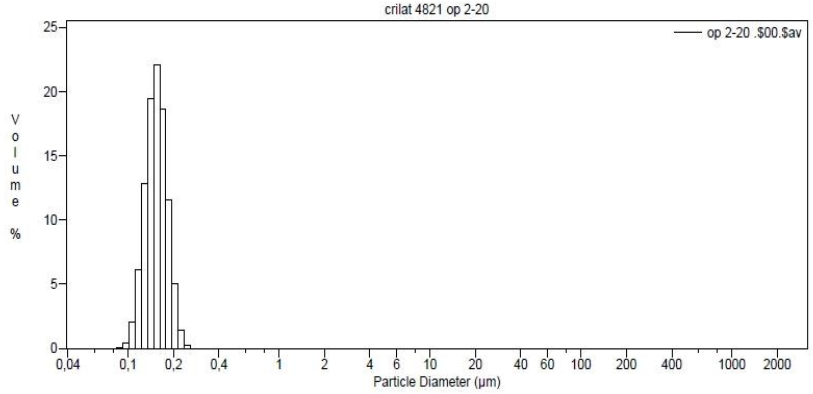
LS Particle Size Analyzer

Vinavil S.p.A. - R&S Lab. ANS

6 Jul 2020

File name: op 2-20 .$00.$av
Sample ID: crilat 4821 op 2-20
Operator: Tedeschi
Optical model: Emulsioni.rfd
LS 230 Fluid Module

Group ID: op 2-20 prod



Volume Statistics (Arithmetic) op 2-20 .$00.$av

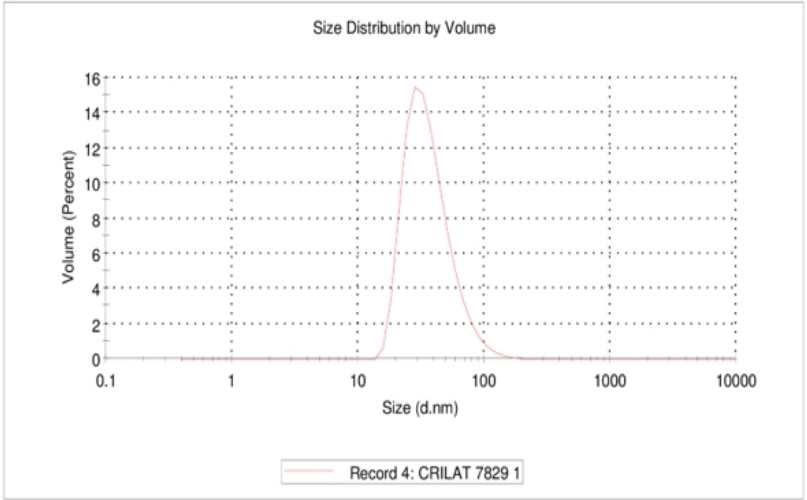
Calculations from 0,0400 µm to 2000 µm

Volume:	100%		
Mean:	0,155 µm	S.D.:	0,026 µm
Median:	0,154 µm	C.V.:	16,5%
Mode:	0,155 µm		
d_{10}:	0,124 µm		
d_{90}:	0,190 µm		

Crilat 7829 nano-technology

Malvern instrument

			Size (d.nm):	% Volume:	St Dev (d.nm):
Z-Average (d.nm):	54,43	Peak 1:	38,07	100,0	18,60
PdI:	0,187	Peak 2:	0,000	0,0	0,000
Intercept:	0,966	Peak 3:	0,000	0,0	0,000
Result quality	Good				



Appearance

Crilat 7829 Conventional polymer

Crilat 7829 Conventional polymer

Persoz hardness

ANALYSIS	UNIT	CRILAT 7829	COMPETITOR 1	CRILAT 7832 new	COMPETITOR 2
Persoz Hardness after 24h	Second	120	117	85	93
Persoz Hardness after 3 days	Second	125	120	86	95
Persoz Hardness after 7 days	Second	132	125	89	97

The **hardness** of a coatings film may be characterized by the attenuation of pendulum swings:

- the harder the film, the longer a pendulum placed on it continues swinging
- the softer the film, the greater the damping of the pendulum oscillations

Clear wood coating

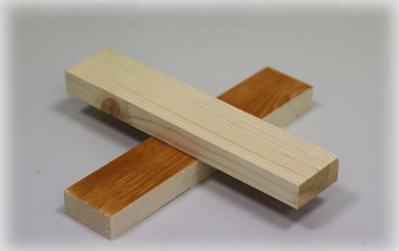
SPRAY/BRUSH APPLICATION

Ref. 09 07 E E P

COMPONENTS	w. %	FUNCTION
Crilat 7829	**89,00**	**Binder**
Tego Airex 904W	1,00	Defoamer
Water	1,80	
Butyl diglycol	2,00	Coalescent
Coatex BR100P	0,20	Thickener
Surfynol 104 DPM	0,60	Wetting agent
Viscoatex 730 (30% in water)	0,20	Thickener
Acticide B20	0,20	Biocide
Tinuvin 477-DW	5,00	UV- Absorber
Total	100,00	

Clear wood coating

ANALYSIS	UNIT	CRILAT 7829	COMPETITOR 1	CRILAT 7832 new	COMPETITOR 2
Film aspect on fir wood	Visual	transparent, bright	transparent, bright	transparent, bright	transparent, bright
Adhesion Cross cut test after 24 h	0 / 5 0= null 5= complete	1	1	1	1
Water whitening after 24h	0 / 5 0= null 5= complete	2	2	1	2
Blocking after 24 h (1 Kg/cm^2 at 23°C x 8h)	0 / 5 0= null 5= complete	1	1	2	2
Blocking after 24 h (0,3 Kg/cm^2 at 50°C x 6h)	0 / 5 0= null 5= complete	2	2	4	4

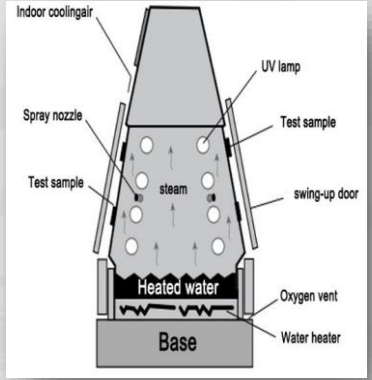


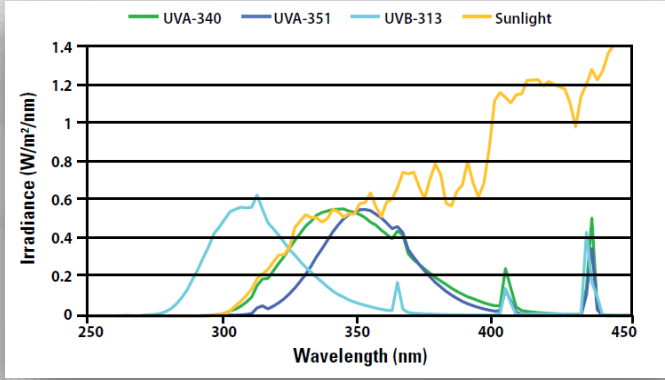
Clear wood coating

	UNIT	CRILAT 7829	CRILAT 7832 new	COMPETITOR 1	COMPETITOR 2
Tensile strength at break After 7 days at 50% RH and 23°C	N/mm^2	6,5	7,4	6,2	5,6
Elongation at break After 7 days at 50% RH and 23°C	%	302	346	321	324

UV-TEST according to EN UNI 927/6

UVA lamp 340nm, water spray





Cycles	Function	Temperature	Time	Condition
1	Condensation	(45 ± 3) °C	24 h	UV off
2	a + b		48 times cycles a+b	
A	UV	(60 ± 3) °C	2,5 h	Irradiance: 0,89±0,1 W/(m²nm) a 340 nm
B	Water spray		0,5 h	6-7 l/min, UV off

UV-TEST: artificial weathering, according to EN UNI 927/6

Both the products pass the UV-test and show excellent durability

Wood coatings interior applications

Features

- Stain and chemicals resistance
- Water resistance
- Surface hardness
- Adhesion
- Fast drying
- Aesthetic properties

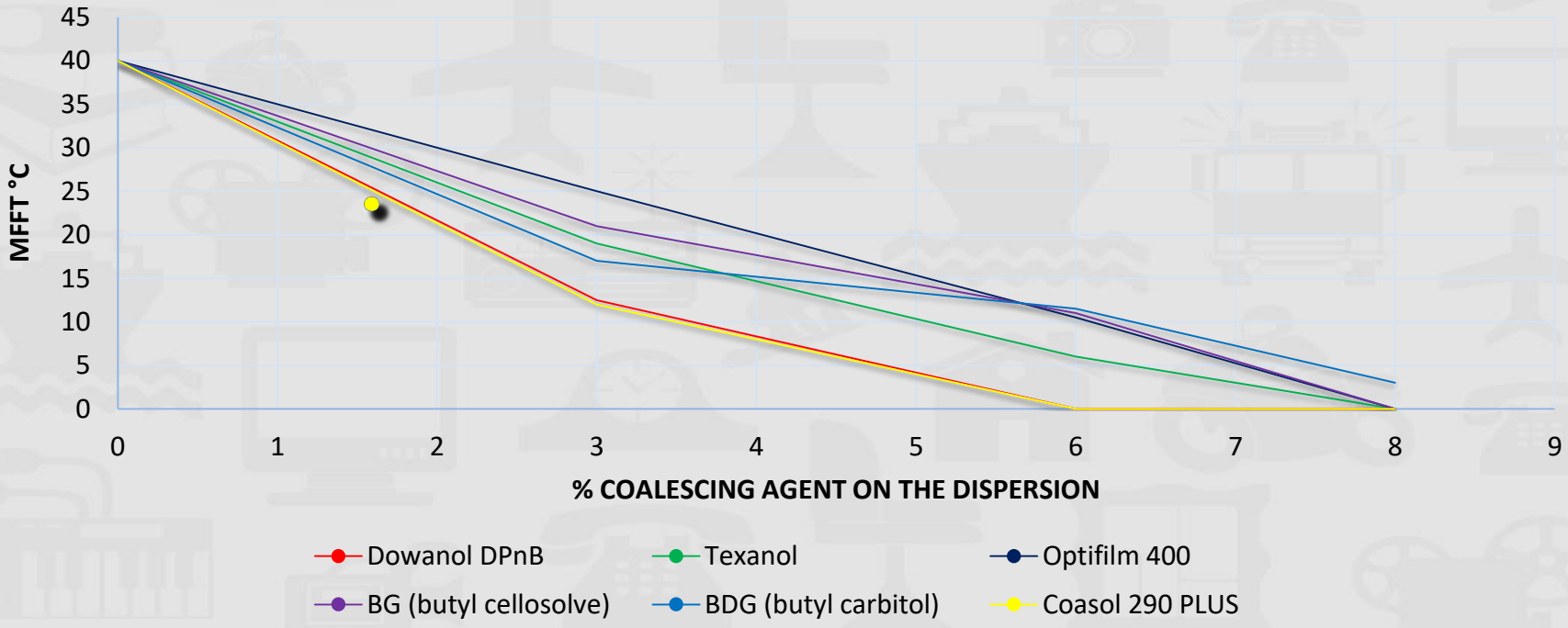
Acrylic for interior wood coatings

	UNIT	CRILAT 7840
Note		Core-shell Self crosslinking
Average particles size	nm	80-120
Tg (*)	°C	+43 / +70
MFFT	°C	40
Solid content	%	45±1
Brookfield viscosity 20 rpm, 23°C	mPaxs	<200
pH	1-14	8.0±0.5
Hydroxyl number (*)	mg KOH/g	8.3

(*) theoretical value

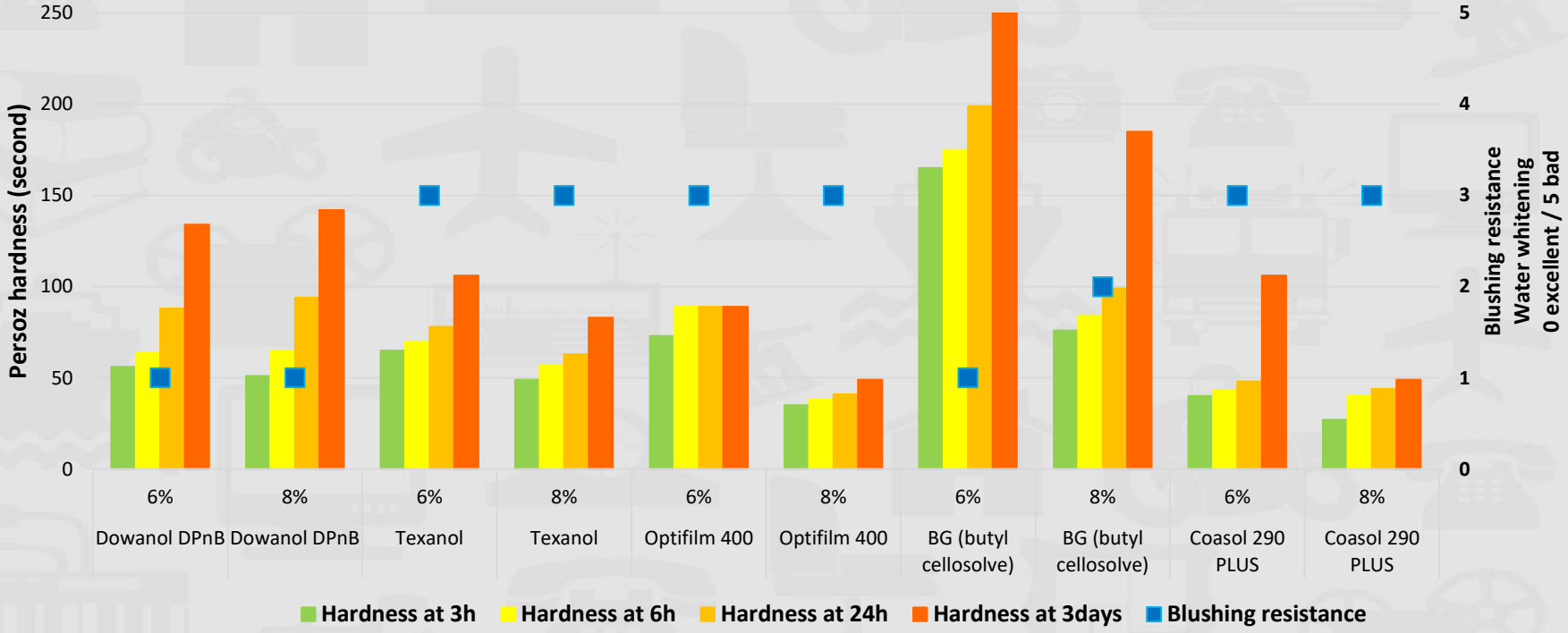
MFFT decrease with coalescing agents

CRILAT 7840



Persoz hardness and blushing resistance

CRILAT 7840



CLEAR INTERIOR WOOD COATING

Ref. 17 08 GLOSS

COMPONENTS	w. %	Function	Suppliers
Crilat 7840	**70,00**	**Binder**	**VINAVIL**
Water	18,00		
BG butyl glycol	4,00	Coalescent	Various
Rheolate 288 (sol 50%)	0,70	PU Thickener	Elementis
Aquacer 539	1,00	Wax	Byk
Tego Airex 902W	1,00	Defoamer	Evonik
BYK 3455	0,50	Wetting agent	Byk
Lanco Glidd 9530	1,00	Surface additive	Lubrizol
NH_3 (28%)	0,10	pH regulator	Various
Acticide B20	0,10	Biocide	Thor
Rheolate 288 (sol 50%)	1,6 (*)	PU Thickener	Elementis
Water	2,00 (*)		
Total	100,00		

(*) Adjust the viscosity to 80-100 second, cup Ford 4

CLEAR INTERIOR WOOD COATING

ANALYSIS	CRILAT 7840	Competitor
Cup Ford 4 Viscosity (s)	98	100
pH	8	7,9
Dry film aspect (*)	Regular	Regular
Blocking resistance (0 excellent- 5 very bad) (1)	3	3
Gloss at 60°	75,8	74,2
Cross cut adhesion (0 excellent- 5 very bad)	1	1
Pencil hardness after 24h	2B medium	2B medium

(*) Spray application (120 gr/m^2) on PU base coat on mahogany

(1) Cycle: 30' at 23°C; 45' at 50°C; 30' at 23°C; Test condition (16h at 40°C, pressure 0,3 kg/cm^2)

PERSOZ hardness

Stain and chemicals resistance according to UNI EN 12720

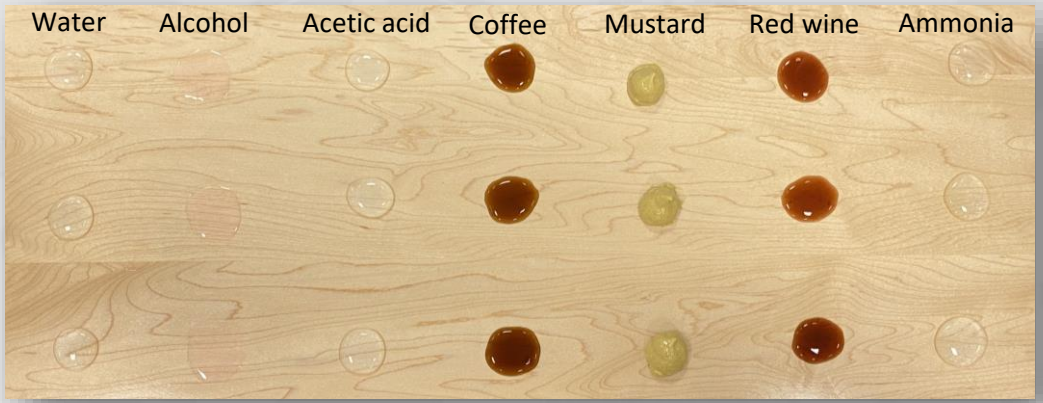
CLEAR INTERIOR WOOD COATING ref. 17 08 GLOSS

Values 0-5
0= Very bad
5= Excellent
(*)

	CRILAT 7840	Competitor
Water 10 min	5	5
Ethyl alcohol 10 min	5	5
Acetic acid (10%) 10 min	5	5
Coffee 10 min	5	5
Mustard 10 min	5	5
Red Wine 10 min	5	5
Ammonia (12%) 10 min	3	3
Water 1 h	5	5
Ethyl alcohol 1 h	4	4
Acetic acid (10%) 1 h	5	5
Coffee 1 h	**5**	4
Mustard 1 h	5	5
Red Wine 1 h	5	5
Ammonia (12%) 1 h	2	2
Water 16 h	5	5
Ethyl alcohol 16 h	2	2
Acetic acid (10%) 16 h	5	5
Coffee 16 h	4	4
Mustard 16 h	4	4
Red Wine 16 h	5	5
Ammonia (12%) 16 h	2	2

(*) Application of wood coating by spray (two hands, total 120 gr/m^2), dry 7 days at 23°C and 50% RH

Stain and chemicals resistance according to UNI EN 12720



10 minutes

1 hour

16 hours

Finish product from the market

10 minutes

1 hour

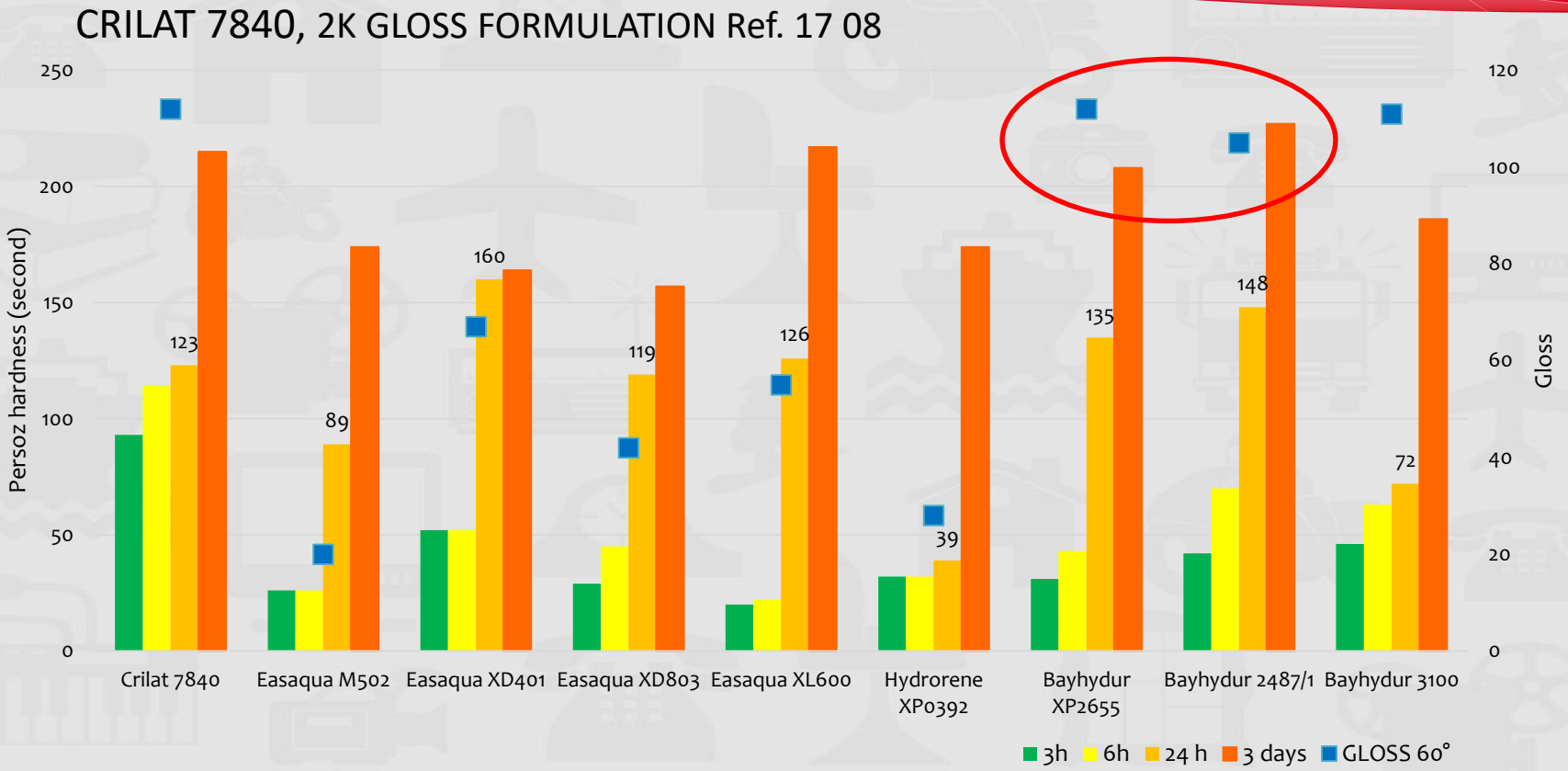
16 hours

Crilat 7840, gloss formula Ref. 17 08 + 10% isocyanate

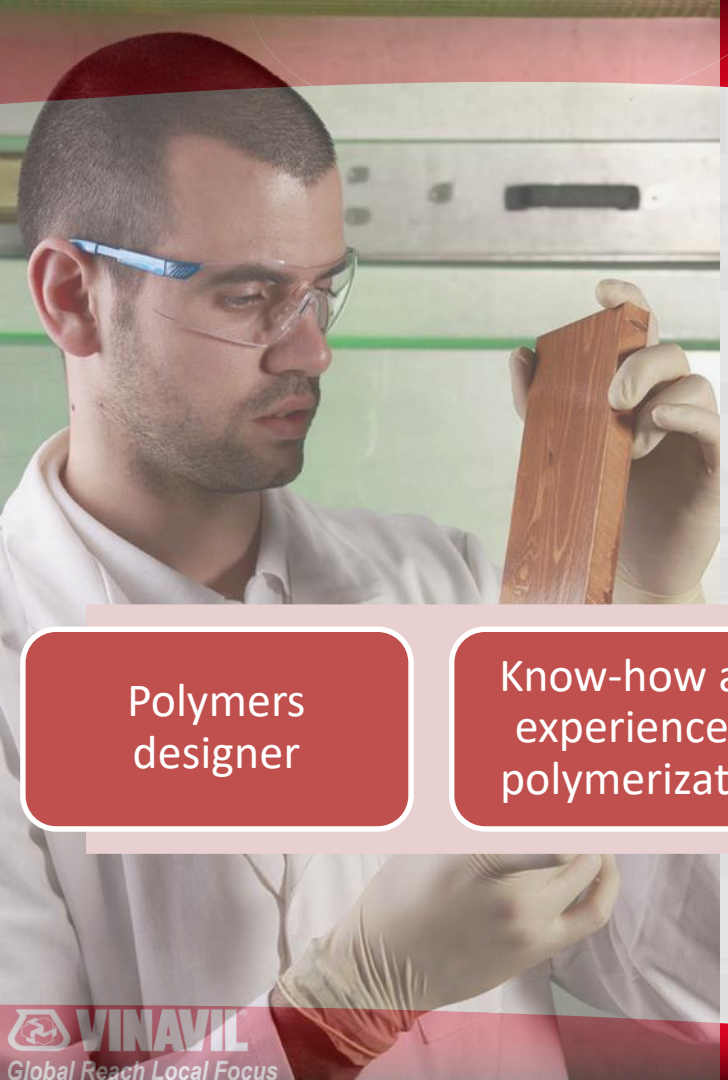
Producer		Vencorex				Sapici	Covestro		
Isocyanate	/	Easaqua M502	Easaqua XD401	Easaqua XD803	Easaqua XL600	Hydrorene XP0392	Bayhydur XP2655	Bayhydur 2487/1	Bayhydur 3100
Pot-Life	/	4 hours	>4 hours	>4 hours	4 hours	>4 hours	>4 hours	>4 hours	>4 hours
Dry film aspect (*)	Regular	Veiled	Veiled	Veiled	Veiled	Veiled	Regular	Regular	small lumps
Gloss at 60°	100	20,4	67,1	41,8	55	27,6	**112**	**105**	**112**

(*) application on glass (150 µm wet film)

PERSOZ hardness and gloss with 10% Isocyanate



Summary



Polymers designer

Know-how and experience in polymerization

Customer Intimacy

VINAVIL®
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Thank you for your attention

Questions?