



# ADVANCEMENT IN SUSTAINABLE RESIN BINDERS FOR WOOD COMPOSITES USING ENGINEERED BIOPOLYMERS

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# Overview

## **EcoSynthetix®**

- Beyond Emissions
- Engineered Biopolymers

## **CHIMAR**

- Applications in Wood Composites

Questions and Answers

# Our VISION

To be one of the world's leading technology and market developers of biobased materials through value-added substitution of fossil-based products. Our enterprise will benefit society as a result of our products being sustainable, based on green chemistry and a reduced carbon footprint.



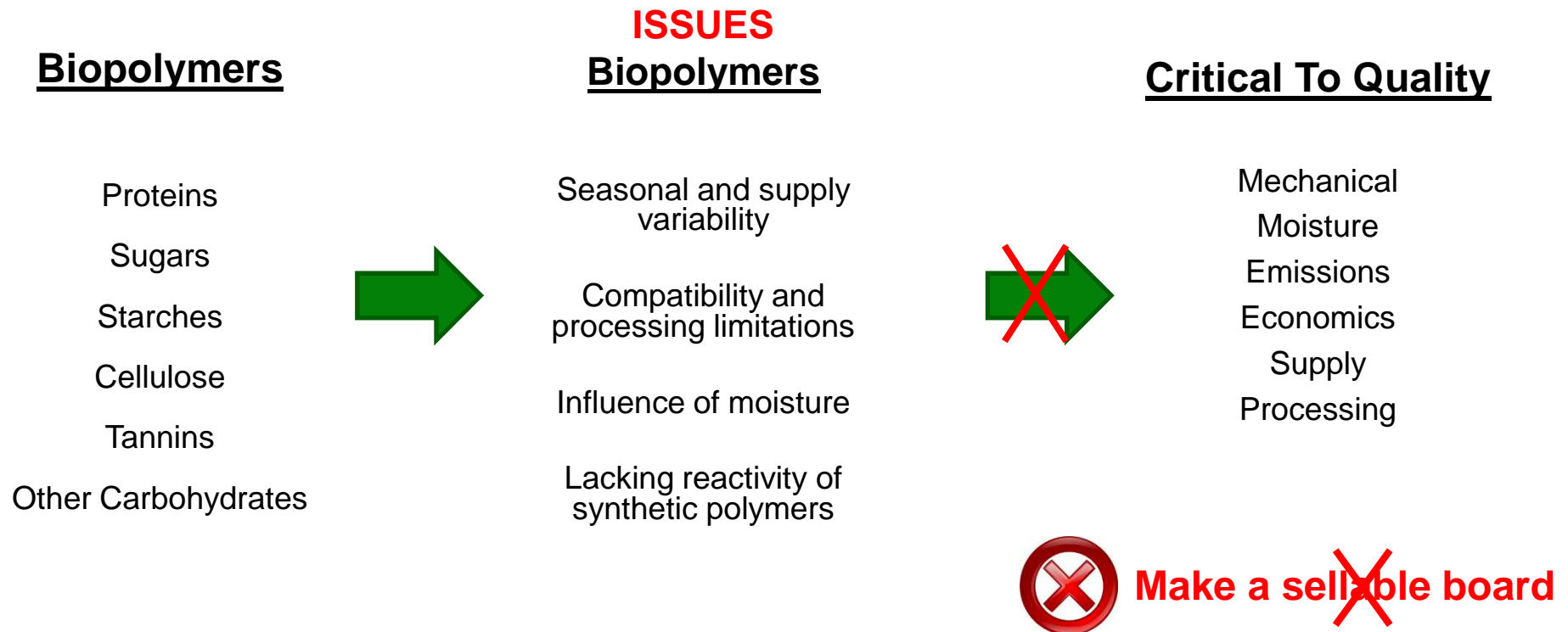
# Beyond the Elimination of Highly Regulated Chemicals

- Strong market driver toward alternatives to highly regulated chemicals because of “sustainability”.
  - Architects: LEED® program
  - Consumer products / retailers: Cradle to Cradle®
  - Underwriters Laboratories, UL: Environmental Product Declaration (EPD)
  - Building products manufacturers: Fiberglass example
- Fiberglass insulation leader example
  - “58% total recycled content”
  - “Contains more than 99% natural ingredients”
  - Minor mention of the elimination of highly regulated chemicals

**It is no longer just about emissions.**

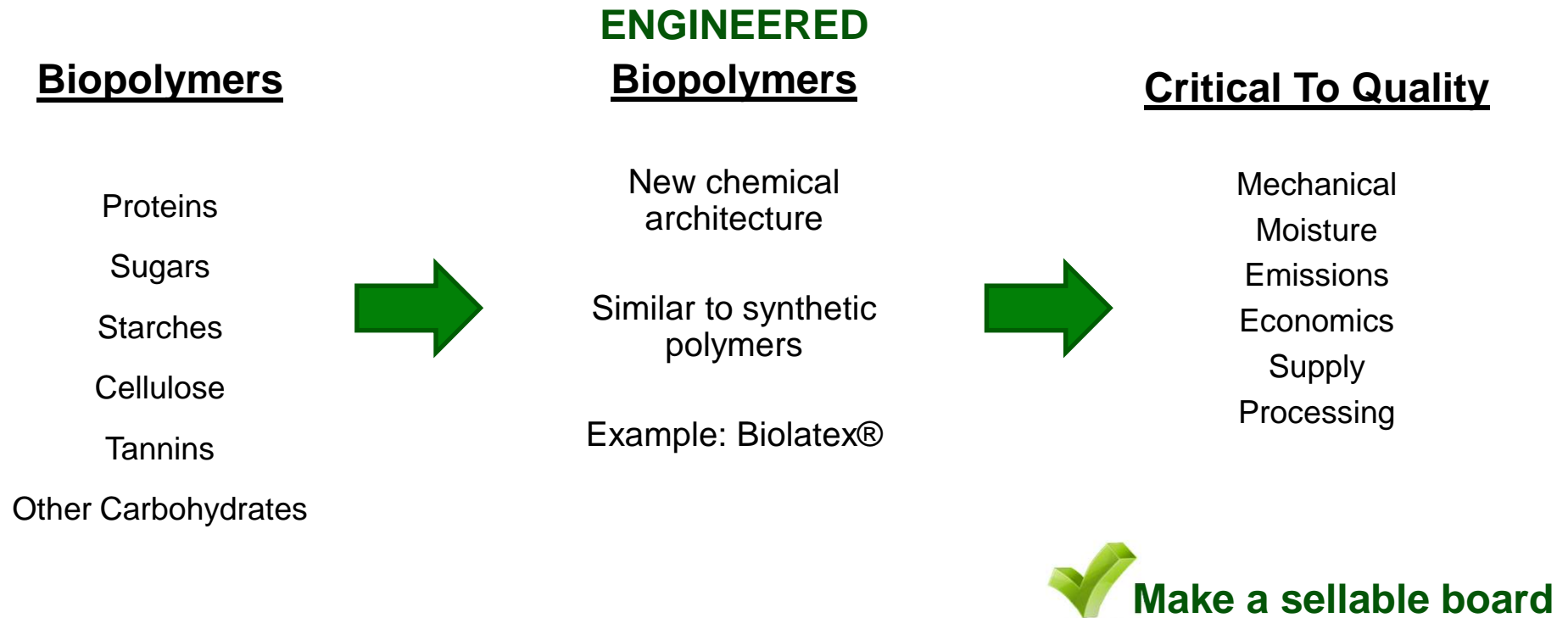
**Going forward it will be about sustainability.**

# Industrial Use of “Traditional” Biopolymers



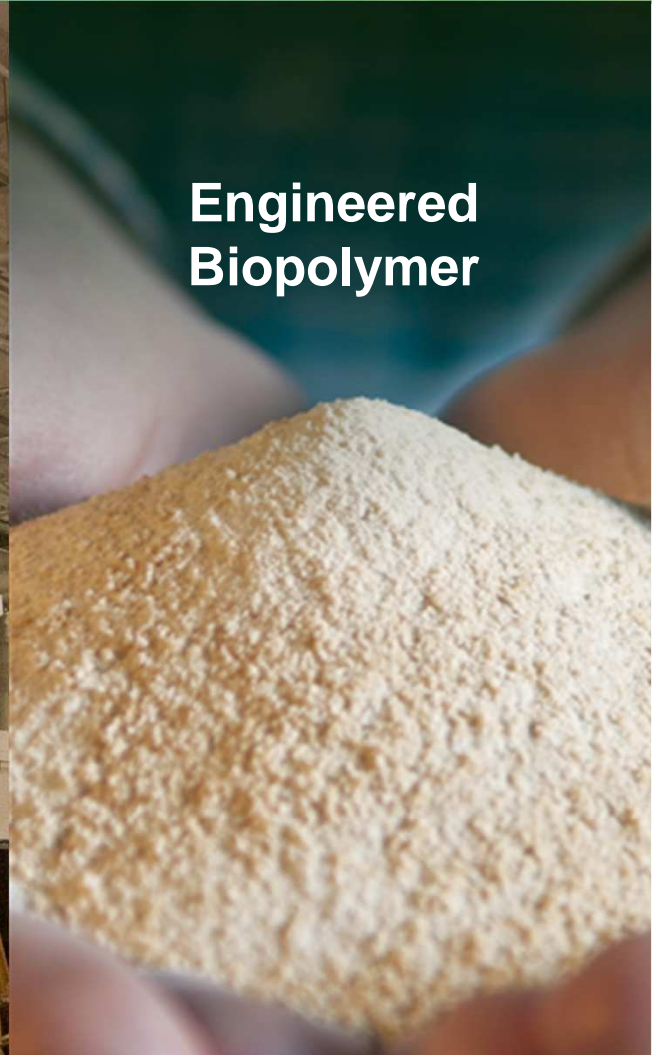
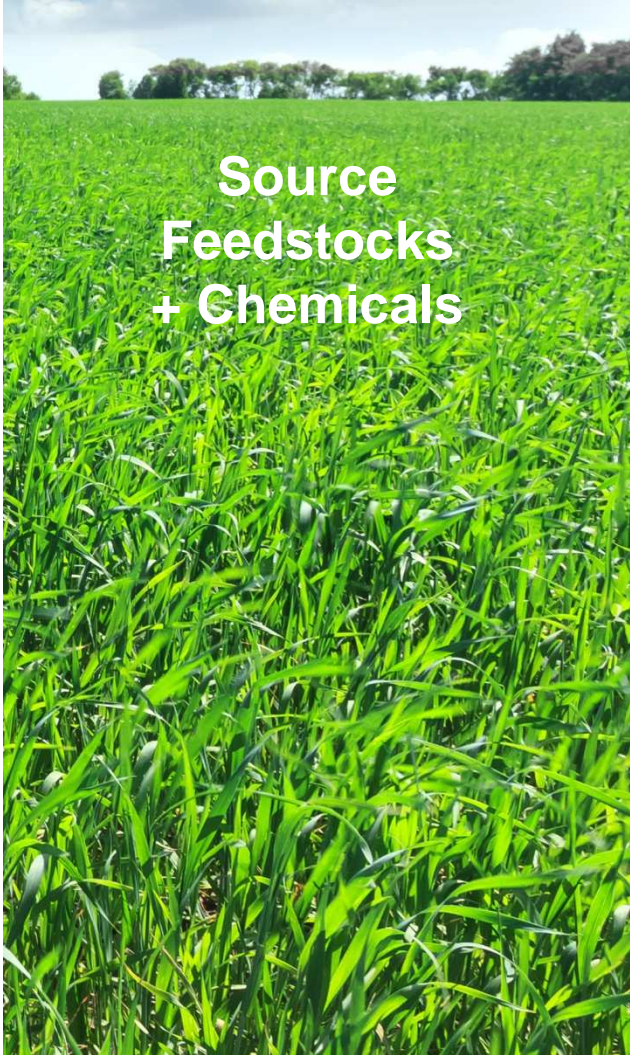
**“Traditional” biopolymers performance can be deficient when compared to classical synthetic polymers**

# Introduction of EcoSynthetix<sup>®</sup> Engineered Biopolymers



**Engineered biopolymers can be tailored for specific applications and replace many synthetic chemistries.**

# How We Are Different From Other Biochemical Players



Patented Formula

Patented Process

Patented Product

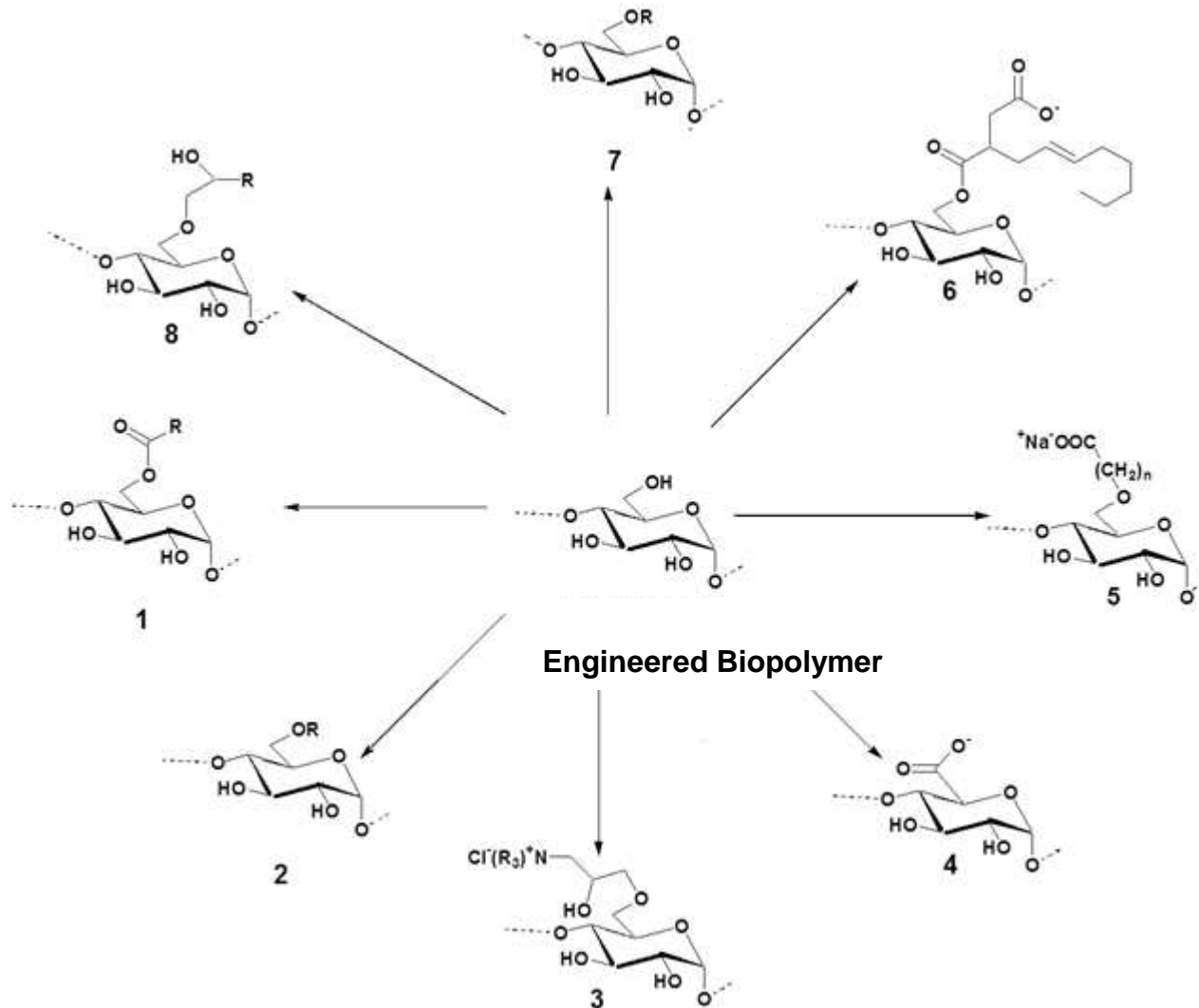
# EcoSynthetix® Engineered Biopolymers with Tailored Properties and Functionalities

Able to customize chemistry to meet the specific requirements of several unique applications.

- Physical properties: Color, viscosity, pH
- Mechanical properties: Tensile strength, flexibility, rigidity
- Moisture resistance: Humidity, soaking or long term weathering
- Cure profiles: Defined activation temperatures for individual process equipment



# Tailored Functionality Through Chemical Modifications Applied

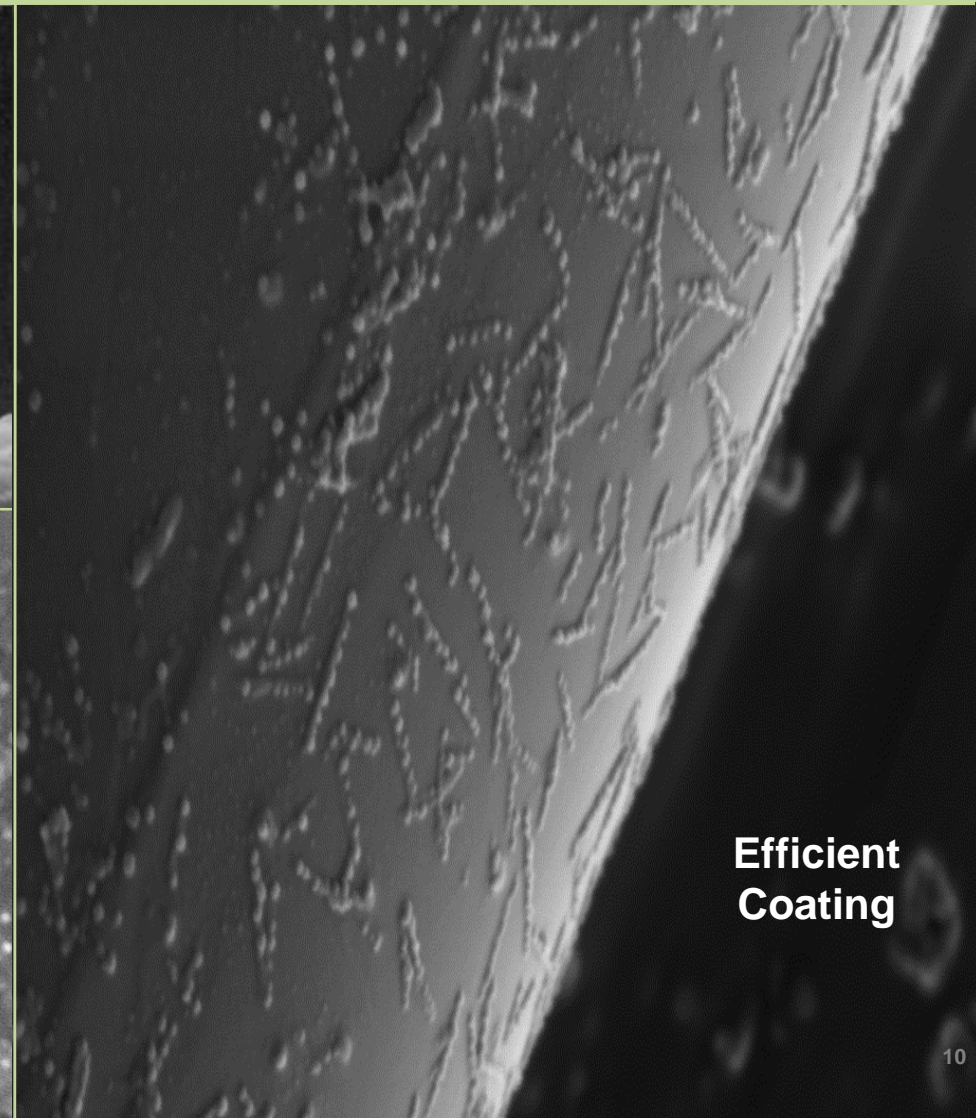
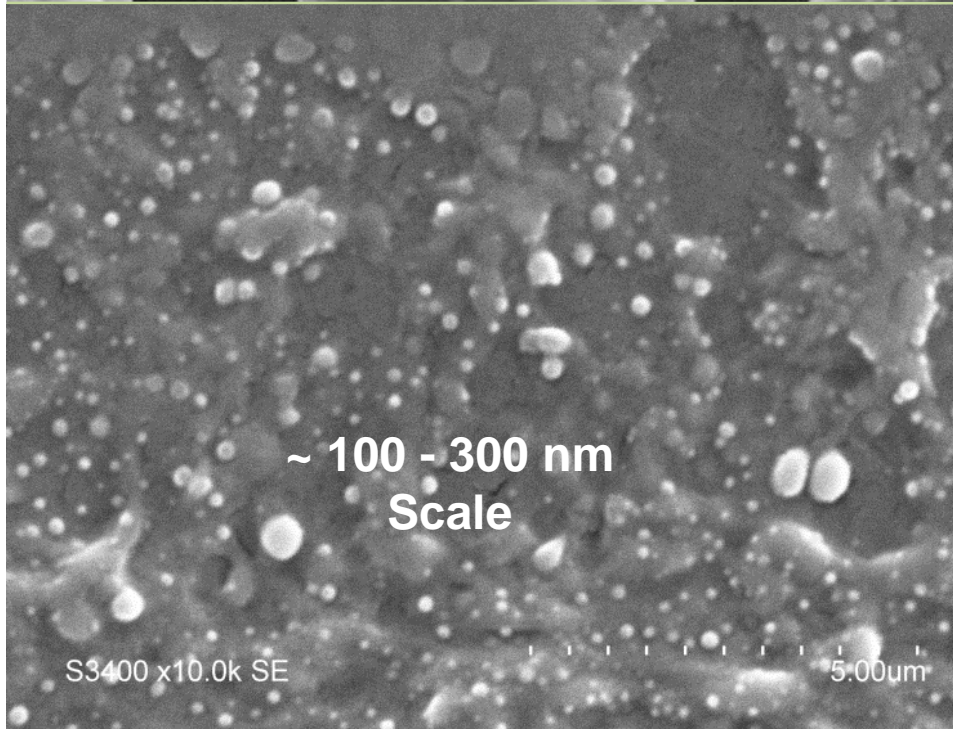
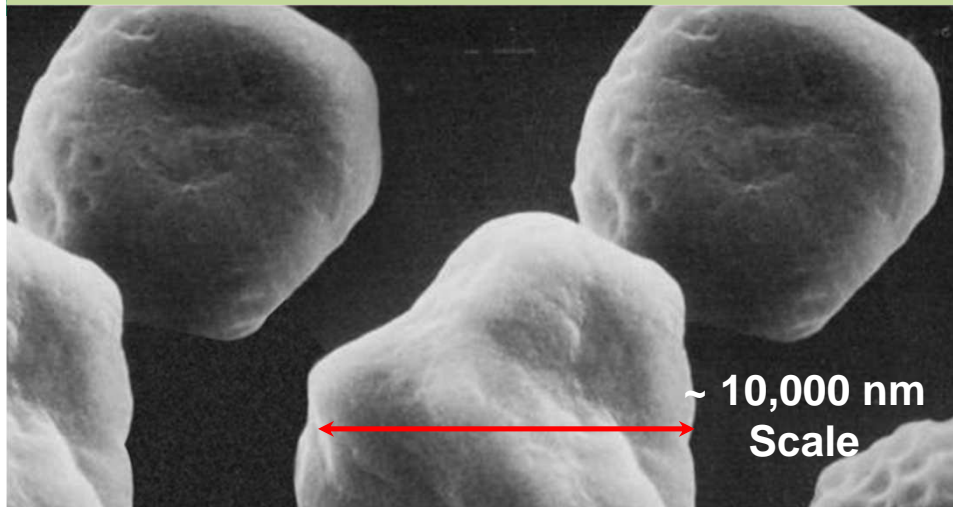


## Applications:

- Wood composites
- Coatings
- Insulation
- Adhesives
- Non-wovens

**Over 100,000,000 pounds sold into Paper Coating Industry**

# Functional Particles with Excellent Binding Properties



100 nm  
Mag = 35.85 K X

WD = 2.6 mm  
EHT = 1.00 kV

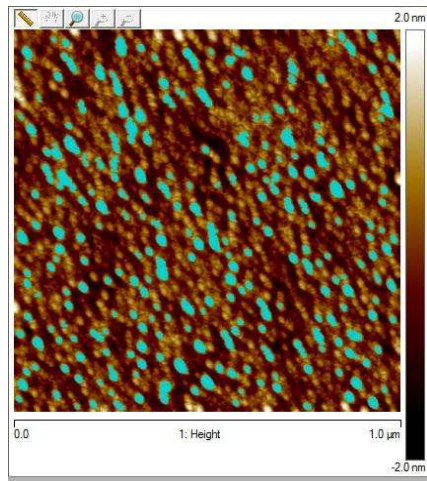
FIB Imaging = SEM  
FIB Image Probe = 30KV:40 pA

Signal A = InLens  
Date :3 Jun 2011

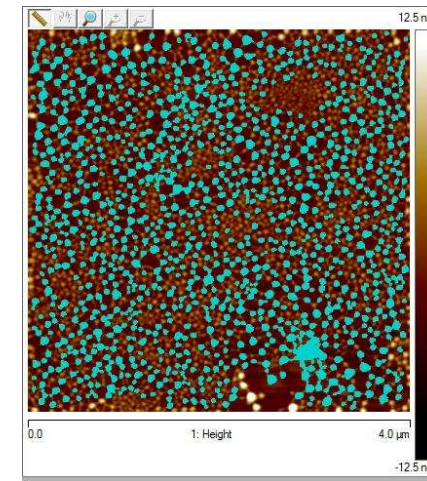
# EcoSynthetix Engineered Biopolymers Demonstrate a High Degree of Compatibility

Demonstrated in Atom Force Microscopy (AFM)

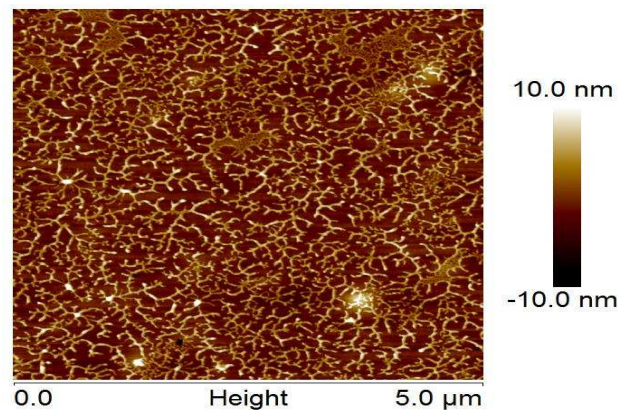
**Incumbent Synthetic Polymers**



**Engineered Biopolymer**



**50/50 Blend**



# Engineered Biopolymers Vs. Traditional Biopolymers Replacing Synthetic Chemistries

Product Characteristic	“Traditional” Biopolymers	Engineered Biopolymers
Quality / Consistency	Seasonal Crop Variability	ISO Certified Continuous Manufacturing
Size / Function	Larger molecules with limited functionality	Smaller functional particles
Processing	“Cooking” or other modifications typically needed	Dispersions broad range of chemical compatibility
<b>Application</b>	<b>Fillers for synthetic chemistry</b>	<b>Replacement for synthetic chemistry</b>

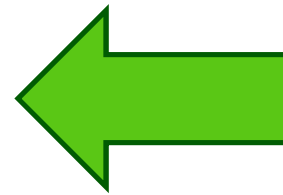
# Overview

## EcoSynthetix®

- Beyond Emissions
- Engineered Biopolymers

## CHIMAR

- Applications in Wood Composites



Questions and Answers

## CHIMAR is Committed to INNOVATION

- CHIMAR is the world leader in supplying industrial know-how for producing resins and resin additives for the manufacture of wood-based panels and impregnated papers. It also offers globally services for plant installation for the production of resins and resin additives as well as their raw materials.



**Global Technology Provider**  
Serving the Resin & Wood Panel Industry

# Lab, Pilot and Industry Trials

## Lab

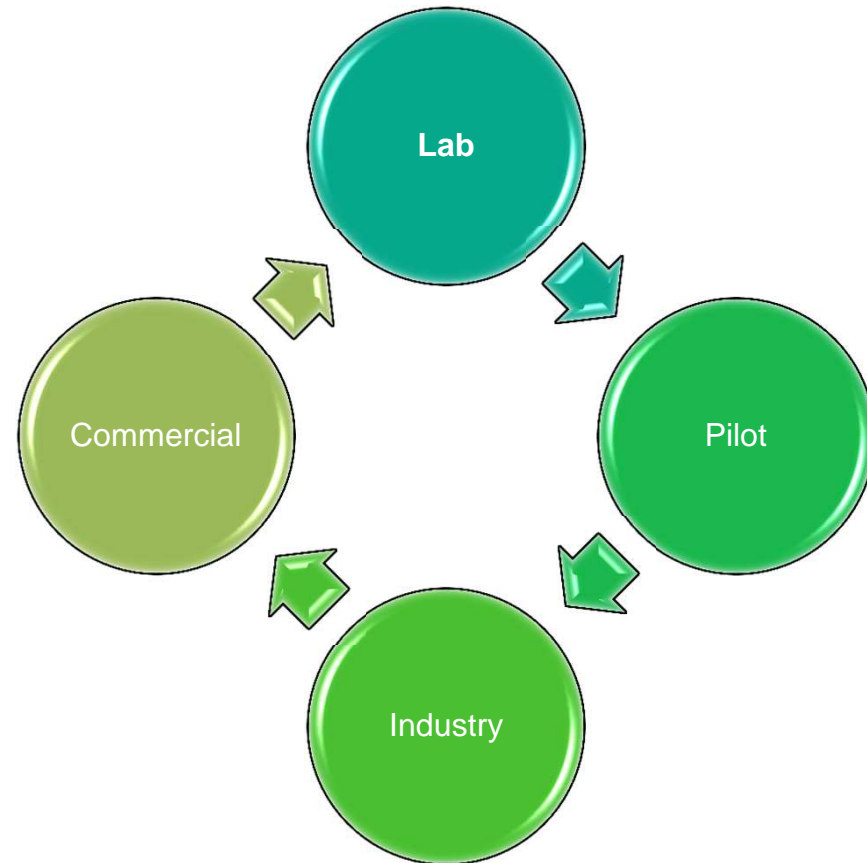
Chimar: Greece

## Pilot

AITF: Alberta Canada

## Industrial

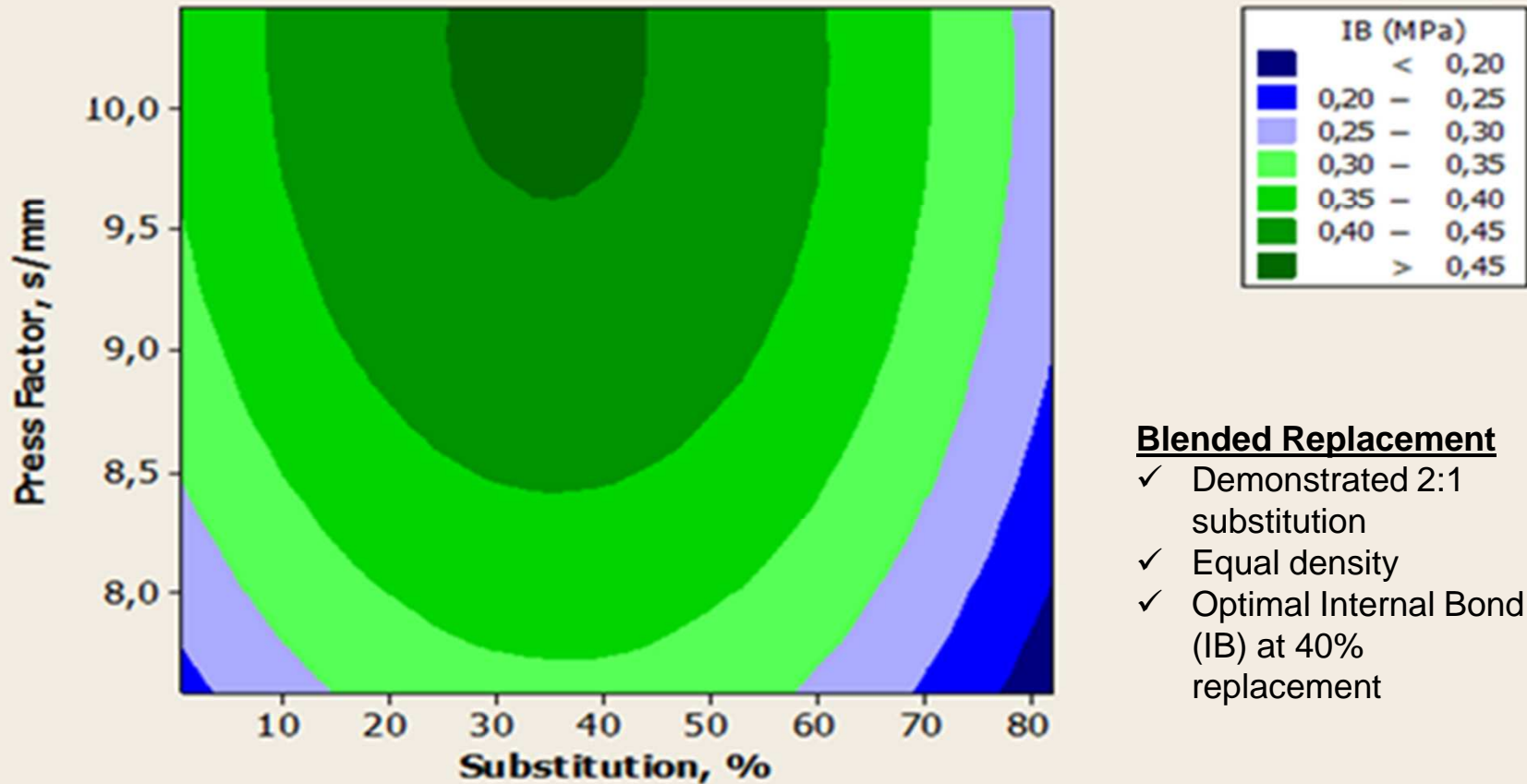
Europe and North  
America



**ALL trials “2:1 Substitution” was demonstrated:**

TWO parts urea formaldehyde with ONE part engineered biopolymer <sup>15</sup>

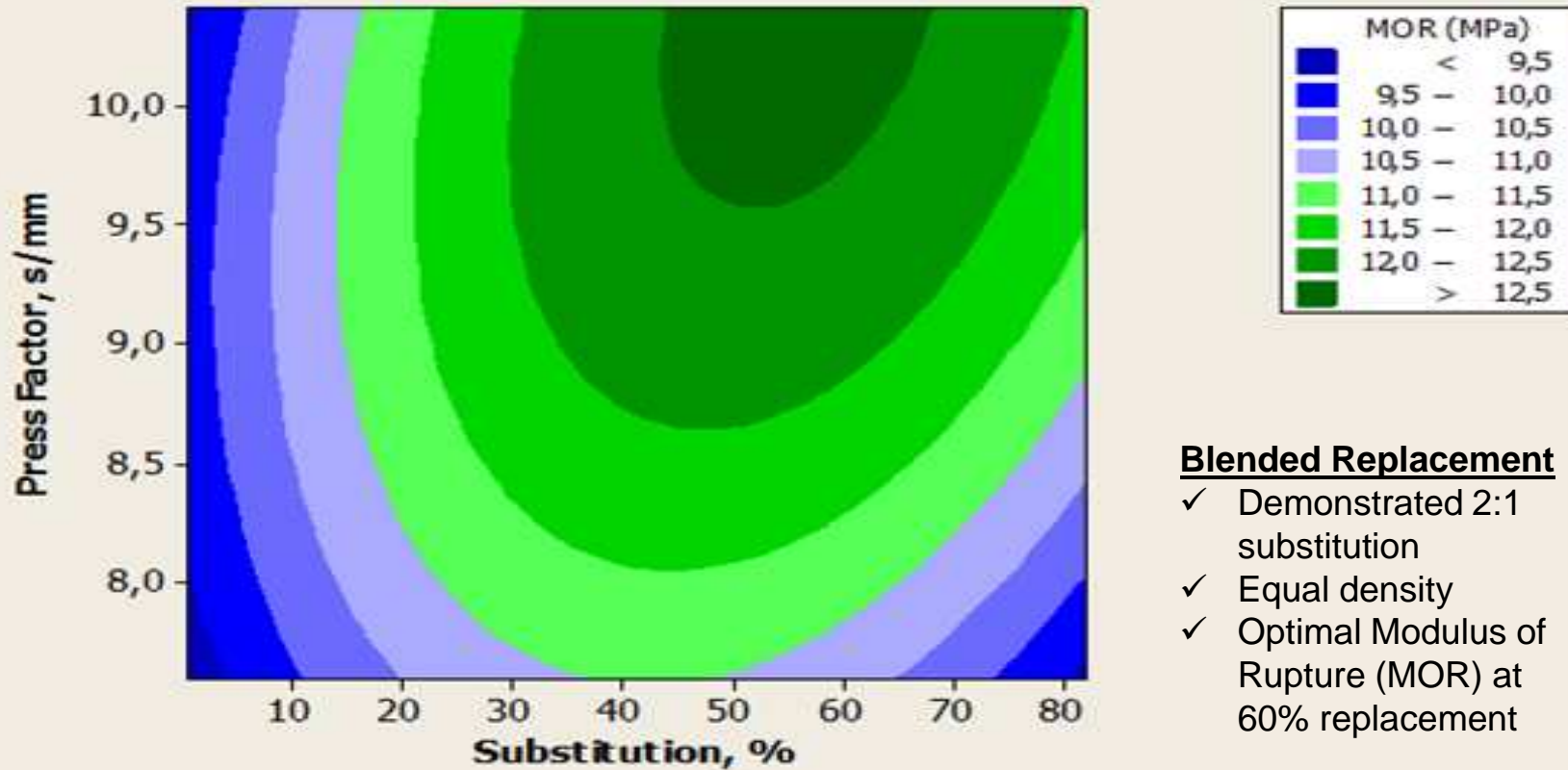
# Internal Bond (IB) vs Biopolymer Substitution Levels Lab Evaluation in Particleboard



Contour plots of Internal Bond (IB) vs. Press Factor, s/mm; Substitution, %



# Modulus of Rupture vs Biopolymer Substitution Level Lab Evaluation in Particleboard



## Blended Replacement

- ✓ Demonstrated 2:1 substitution
- ✓ Equal density
- ✓ Optimal Modulus of Rupture (MOR) at 60% replacement

Contour plots of Modulus of Rupture (MOR) vs. Press Factor, s/mm; Substitution, %

# Pilot Scale MDF Trial Results

## Conditions

Panel Product	Single Layer MDF
Panel density, kg/m <sup>3</sup>	800
Resin type	UF 096D
Press temperature, °C	160
Wood mix: 60% lodgepole pine, 40% white spruce with a small % of balsam fir	

## Results

Description / Property	Values		
% replacement (2 to 1 substitution)	30%	60%	0%
Average Density, kg/m <sup>3</sup>	800	810	800
Average IB, N/mm <sup>2</sup>	0.50	0.62	0.60
Average MOR, N/mm <sup>2</sup>	19	18	19

- ✓ Demonstrated 2:1 substitution
- ✓ Equivalent density
- ✓ Equivalent Internal Bond (IR) and Modulus of Rupture (MOR)
- ✓ Up to 60% replacement at pilot facility

# Industrial Scale Particle Board and MDF Trial Results

Industrial Samples	MDF			Particleboard		
	% replacement (2 to 1 substitution)	20%	30%	0%	30%	40%
Average Density, kg/m <sup>3</sup>	700	710	720	680	710	700
Average IB, N/mm <sup>2</sup>	0.68	0.67	0.68	0.56	0.46	0.50
Average MOR, N/mm <sup>2</sup>	26.6	28.3	27.2	14	12	13

- ✓ Demonstrated 2:1 substitution
- ✓ Equivalent density
- ✓ Equivalent internal bond (IR) and Modulus of Rupture (MOR)
- ✓ Up to 40% substitution at industrial trials

# Latest Lab Data 100% Replacement in Particle Board

Description	UF / UmF	50% sub	100% face, 50% core	100%ECO
Face Resin on wood (UmF 0.85/066)	10.0%	5.0%		
Face ECO on wood (Gen 1)		2.0%	5.0%	5.0%
Core Resin on wood (UF 1.10)	10.0%	5.0%	5.0%	
Core ECO on wood (Gen 2 cross linker)		2.0%	2.0%	5.0%
IB Average (MPa)	<b>0.32</b>	<b>0.33</b>	<b>0.34</b>	<b>0.35</b>
Density Average (Kg/m <sup>3</sup> )	672	682	688	679
2h Swelling Average (%)	<b>7.3</b>	<b>7.3</b>	<b>7.4</b>	<b>6.1</b>
24h Swelling Average (%)	<b>32.4</b>	<b>29.2</b>	<b>30.4</b>	<b>30.8</b>
MOR (MPa)	<b>8.2</b>	<b>8.8</b>	<b>10.8</b>	<b>11.5</b>
MOE (MPa)	1998	1964	2001	2013
Thickness (mm)	15.2	15.2	15.2	15.2
Perforator Value (mg/100g)	<b>3.4</b>	<b>3.6</b>	<b>2.5</b>	<b>0.8</b>
Gas Analysis (mg/m <sup>2</sup> h)	<b>1.5</b>	<b>1.2</b>	<b>0.9</b>	<b>0.5</b>

**Producing a wood composite board that is equal or better than the UF / UmF standard in mechanical, moisture and emissions board properties.**

## Now is the Time to Consider EcoSynthetix® Engineered Biopolymers

- ✓ Compatibility with incumbent resin technologies with 10% to 100% Substitution.
- ✓ Existing equipment utilized with seamless transition between resin systems.
- ✓ Mechanical properties are maintained compared to incumbent resin systems.
- ✓ Significant improvement in bonding efficiency.
- ✓ Carbon footprint reduction from 33% to 75%.
- ✓ New generations of engineered biopolymers achieving 100% substitution.
- ✓ Strong technical team to support your journey.

The ultimate goal of a cost effective sustainable binder for wood composite boards is in reach and being trialed today

Collaboration and open innovation provides the path forward to a sustainable economy.

We welcome the opportunity to determine which products are best for your requirements and sustainability goals.

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Q / A

# Thank you

Eleftheria Athanassiadou from CHIMAR  
Charles Markessini from CHIMAR



Chris Anderson from EcoSynthetix  
Somaieh Salehpour from EcoSynthetix  
Doug Ireland from EcoSynthetix  
Alexander Tseitlin from EcoSynthetix



# Introduction to CHIMAR

Chimar Hellas S.A.



## FACTS & FIGURES:

- ❖ Expertise >37 years in 40 countries
- ❖ Chemicals of our technology in > 5% of global annual wood panel production
- ❖ 25-strong team (chemists, chemical engineers, forest & wood scientists)
- ❖ Participation in >40 international R&D projects and >10 Science & Technology networks

## ACTIVITIES:

- ✓ Developer and supplier of technology for the industrial production and application of adhesive resins and additives for wood-based panels
- ✓ Engineering & equipment procurement services for formaldehyde/UFC/resin/chemical additives plants
- ✓ R&D for third parties, Technical support for field industries (remotely and on-site), Testing, Evaluation, Consulting, Training, Accredited formaldehyde testing (EN ISO/IEC 17025)
- ✓ Specialty chemicals production on demand (Hardeners, FR, Wetting agents)
- ✓ Industrial Equipment Representation
- ✓ Acting globally, helping locally!