

SILICONE SURFACTANTS TO ENHANCE THE PERFORMANCE OF POLYISOCYANURATE RIGID FOAMS

Presenter: **Dr. Christy Chan**

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HOW CAN MOMENTIVE ENABLE **SUSTAINABLE SOLUTIONS** FOR YOUR **RIGID FOAM** PRODUCT?

- Momentive high purity **surfactants** enable the use of **Bio-based polyols**
- Momentive offers sustainable **catalyst** solutions for **PIR foam**



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At Momentive, we create **Solutions for a Sustainable World™**



PERFORMANCE ADDITIVES

Our Materials Enhance Product Performance and Enable Solutions for a Sustainable World

- Agricultural adjuvants drive **higher crop yields that support sustainable farming**
- Consumer beauty and personal care products deliver that **feel-good sensation consumers desire**
- Tire technology increases **fuel and battery efficiency for conventional autos and electric vehicles around the world**
- Eco-conscious paints, coatings, and adhesives support a **healthier air environment where you live and work**



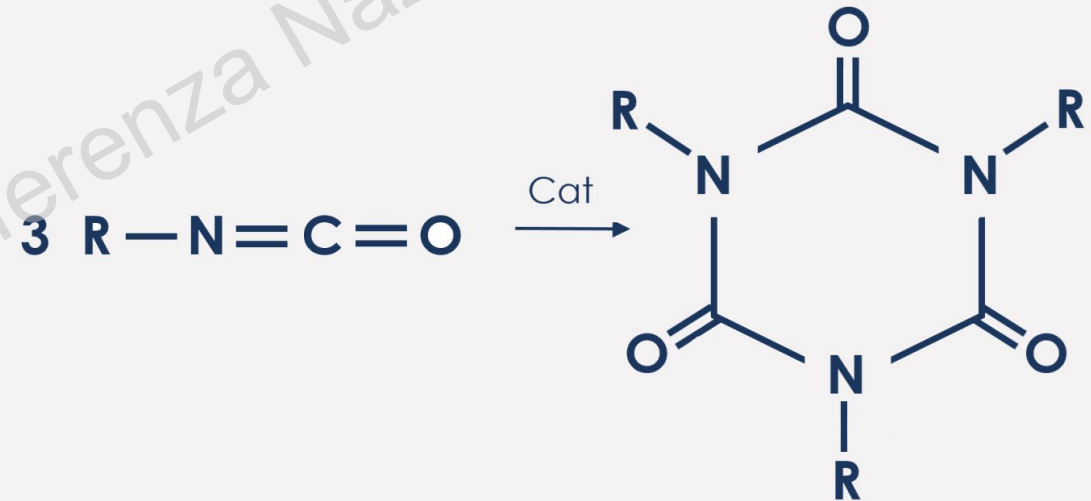
FORMULATED SPECIALTIES

Our Products Enrich Lives by Enabling Pioneering Technologies

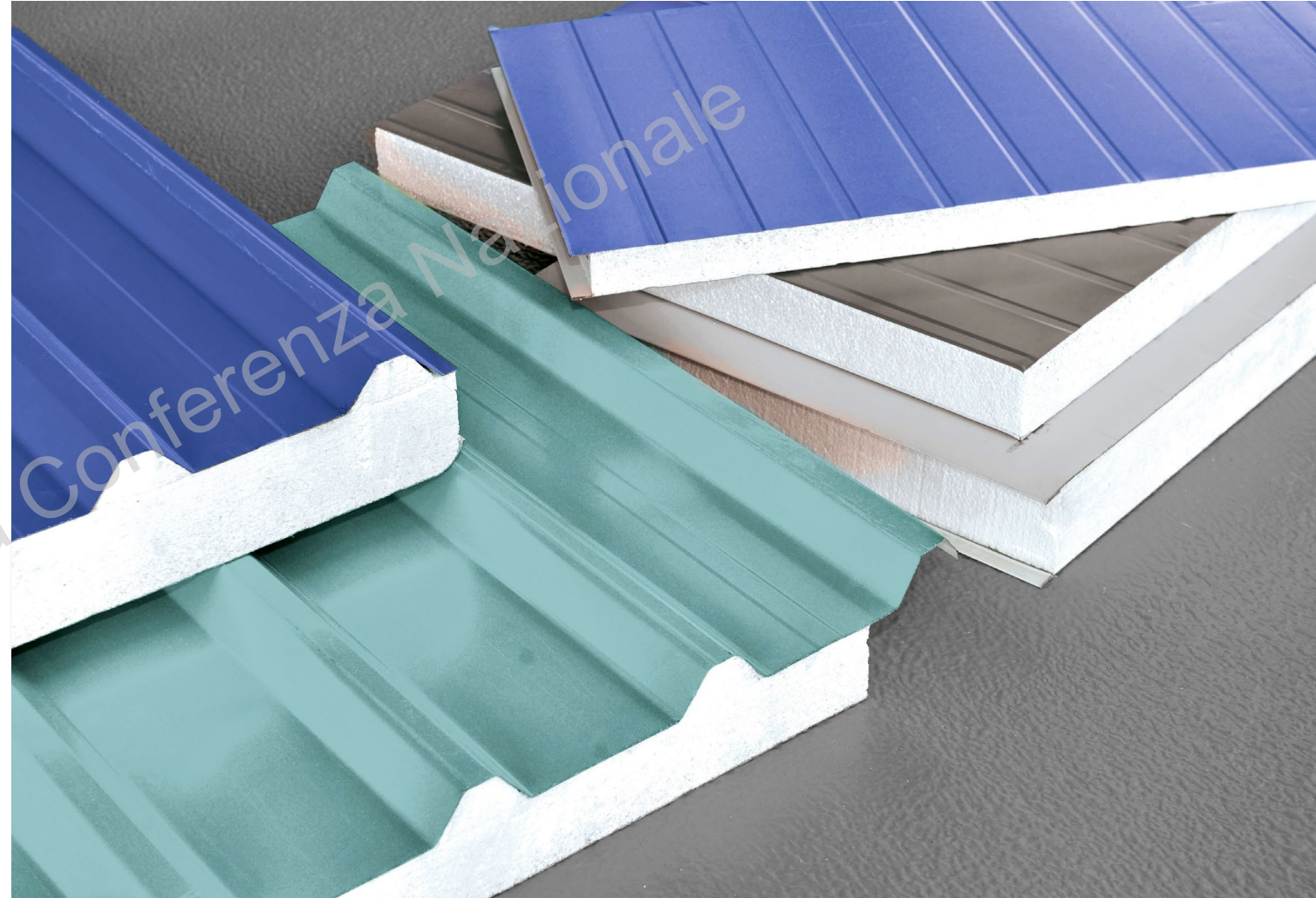
- Silicone technology used in space flights **helps aviation and aerospace pioneers safely reach greater heights**
- Silicone technology used in medical grade-tapes, wound dressing and tubing, **enhances our health and wellness**
- Hardcoats that protect sensor assemblies and thermal management materials that help cool batteries **enable sustainable and safe mobility**
- **Construction Sealants** help buildings withstand challenging climates and conditions, **maintain air quality, improve temperature control, and reduce energy consumption**



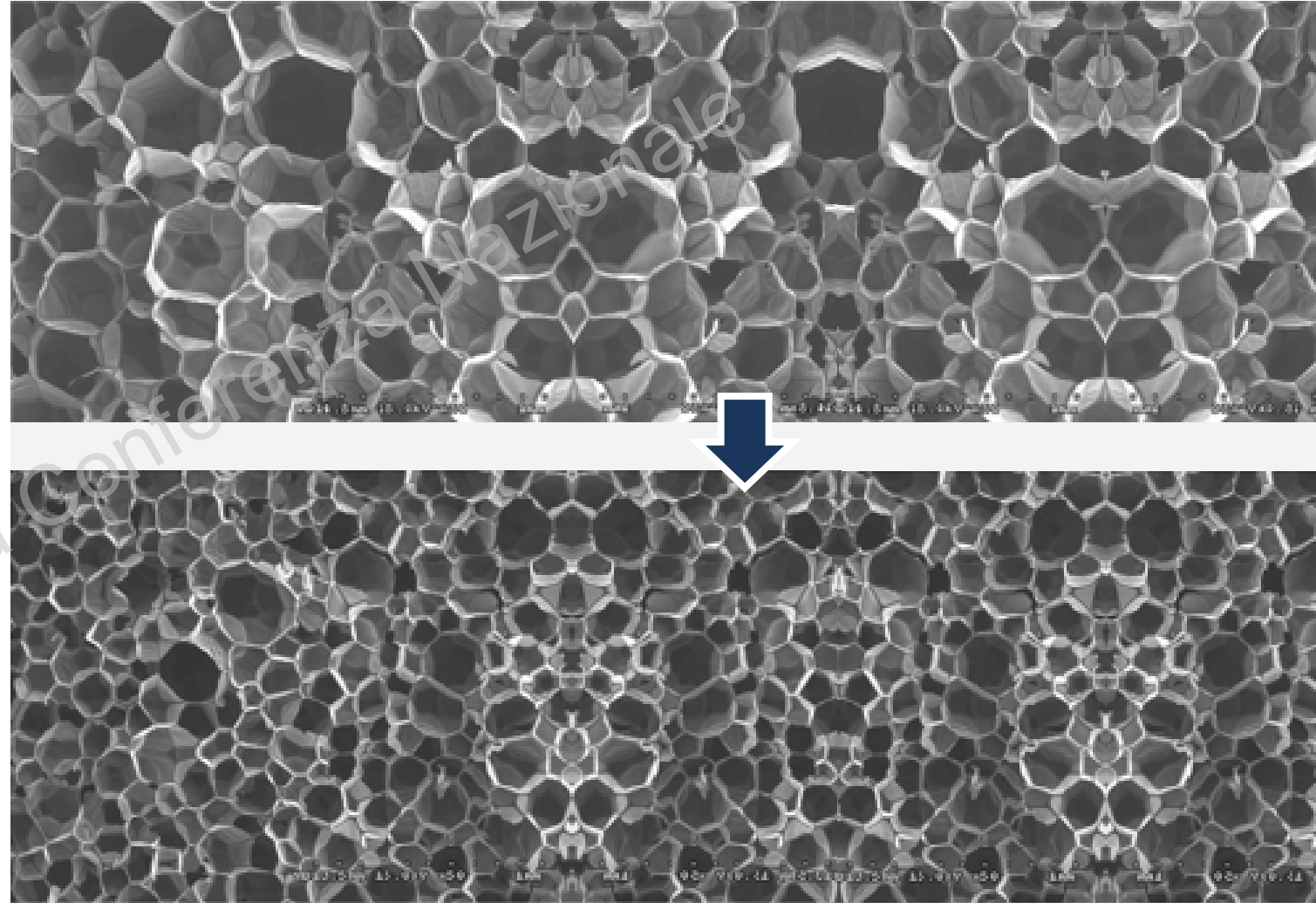
- A formulation category designed for the production of rigid foams by using an excess of isocyanate to generate **isocyanurate** bonds. These contribute to a higher foam FR performance.
- The **dominant formulation/foam type** as core material of insulation panels produced by **continuous lamination** (excellent performance and an attractive set of processing benefits).



- Insulation panels are faced with different materials: the two main categories are **flexible facings** (aluminum, paper, bitumen,...) and **rigid metal facings**.
- All require **low thermal conductivity** as main foam property. **Metal-faced panels** require **minimal voids formation** for a suitable panel quality over the life cycle.



- **Silicone-based surfactants** are critical formulation ingredients, contributing to a high degree of **cellular structure control**, **driving thermal insulation** and **minimizing voids**.



How Does The Surfactant Help Thermal Insulation?

$$\lambda = \lambda_{\text{gas}} + \lambda_{\text{radiative}} + \lambda_{\text{solid}} + \lambda_{\text{convection}}$$

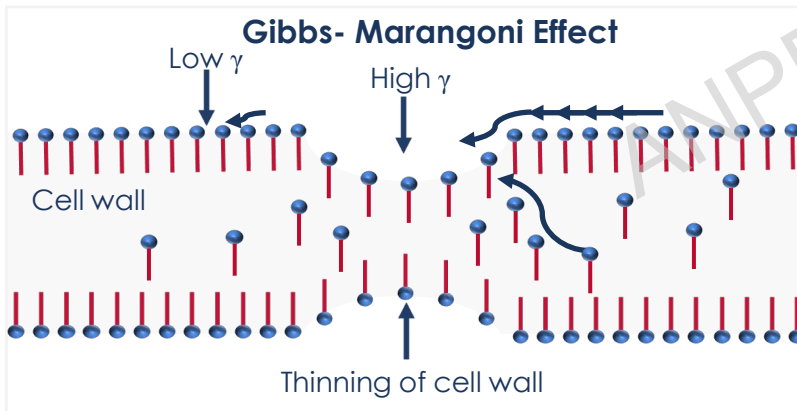
Overall foam thermal conductivity

The lower, the better
(= high thermal insulation)

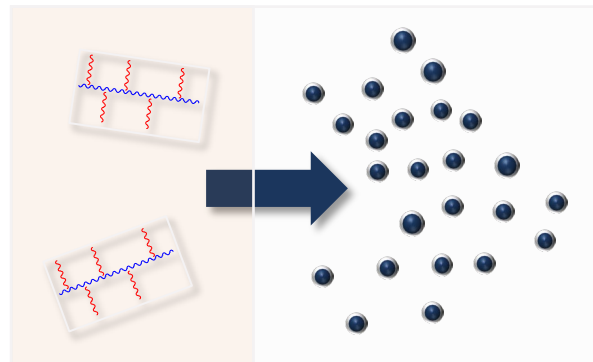
Small cell size

SURFACTANT

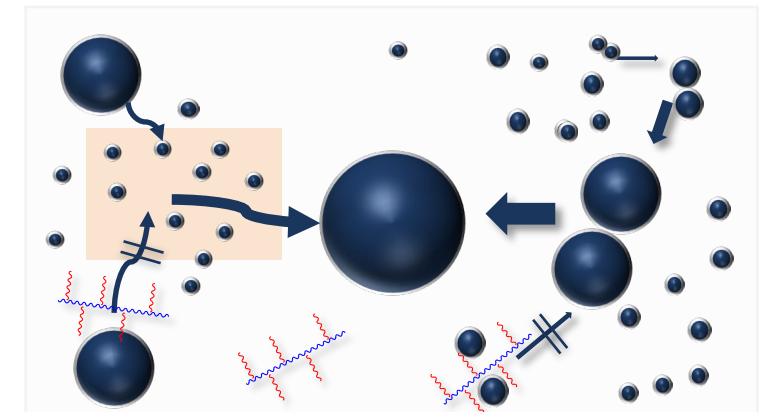
Maintain cell wall elasticity



Nucleation, leading to fine cells



Cell growth by Ostwald ripening and coalescence effect

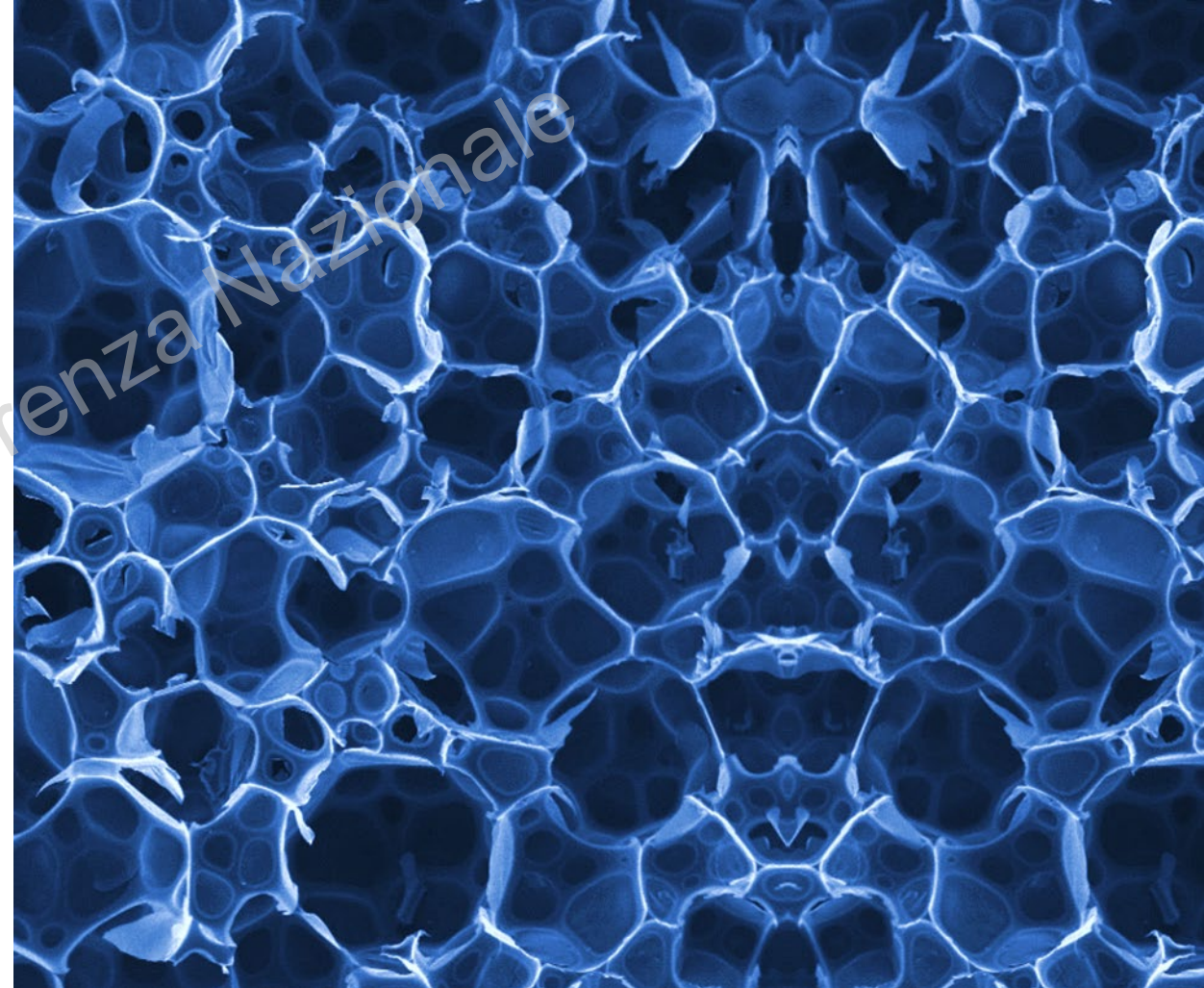


A set of different PIR formulations were used in this work as follows:

FORMULATION 1

FORMULATION 2

FORMULATION 3



A set of different PIR formulations were used in this work as follows:

FORMULATION 1

FORMULATION 2

FORMULATION 3

REGULAR POLYESTER POLYOL*1

BIO-POLYOL** 1

BIO-POLYOL** 2

N-pentane blown - Iso index 300

- Typical free rise density: 36 kg/m³
- Typical gel time: 37 sec.
- 600 mPa•s viscosity MDI

* Petroleum-based aromatic polyester polyol commonly used in rigid foam PIR formulations

** Polyol containing renewable sources for use in rigid foam PIR formulations

A set of different PIR formulations were used in this work as follows:

FORMULATION 1

FORMULATION 2

FORMULATION 3

REGULAR POLYESTER POLYOL*1

BIO-POLYOL** 1

BIO-POLYOL** 2

Cyclo-pentane blown - Iso index 300

- Typical free rise density: 36 kg/m³
- Typical gel time: 37 sec.
- 200 mPa•s viscosity MDI

* Petroleum-based aromatic polyester polyol commonly used in rigid foam PIR formulations

** Polyol containing renewable sources for use in rigid foam PIR formulations

A set of different PIR formulations were used in this work as follows:

FORMULATION 1

FORMULATION 2

FORMULATION 3

REGULAR POLYESTER POLYOL*2

N-pentane blown - Iso index 300

- Typical free rise density: 35 kg/m³
- Typical gel time: 50 sec.
- 600 mPa•s viscosity MDI

* Petroleum-based aromatic polyester polyol commonly used in rigid foam PIR formulations

** Polyol containing renewable sources for use in rigid foam PIR formulations

FORMULATION 1

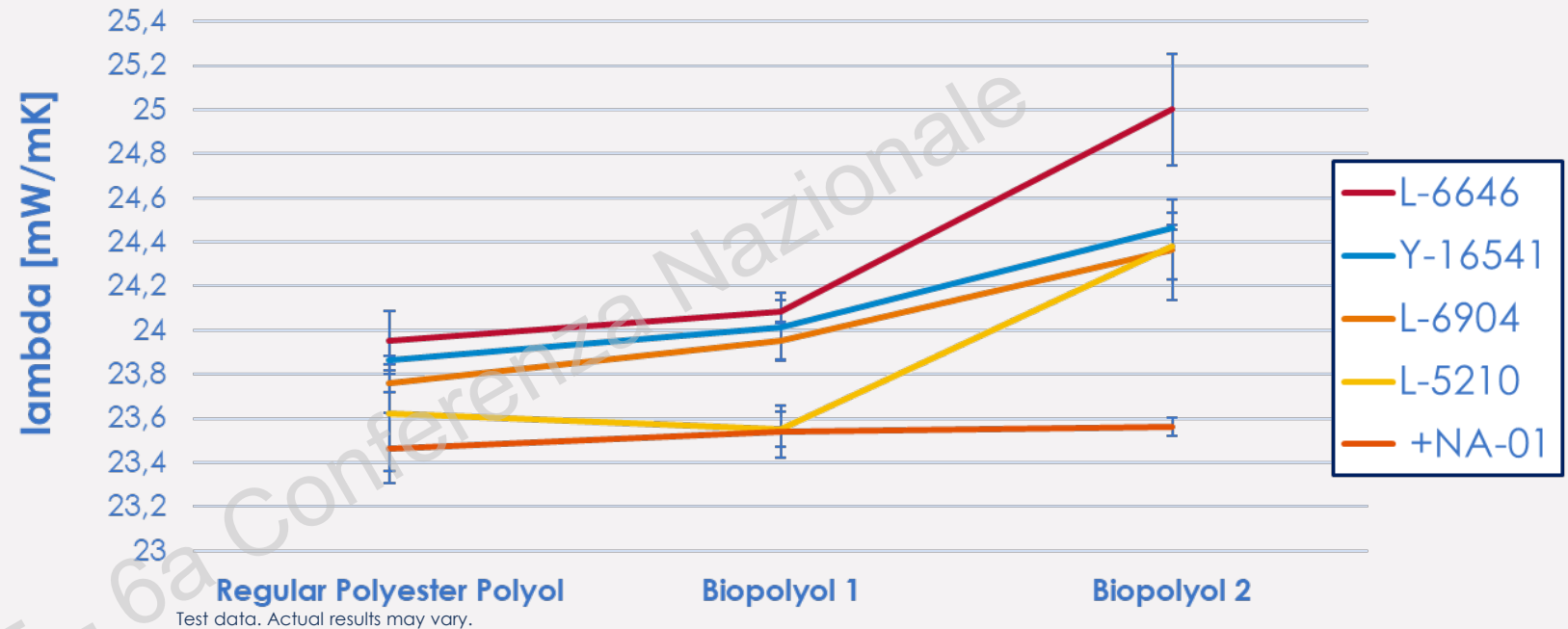
Free rise foams

Surfactant Level 3P*

*Except: 1.5 NA-01+3 P L-6646

Lambda: 0-10 °C

Gel time: 37 sec

Density: 36 kg/m³

- Foams based on Regular Polyester Polyol show better thermal conductivity results vs. foams based on the Bio-polyols.
- **Niax™ surfactant L-5210** and **nucleating additive NA-01** can lower thermal conductivity in foams based on Regular Polyol Polyester and Bio-polyol. This can enable similar or improved thermal conductivity performance for Bio-polyol based foams.

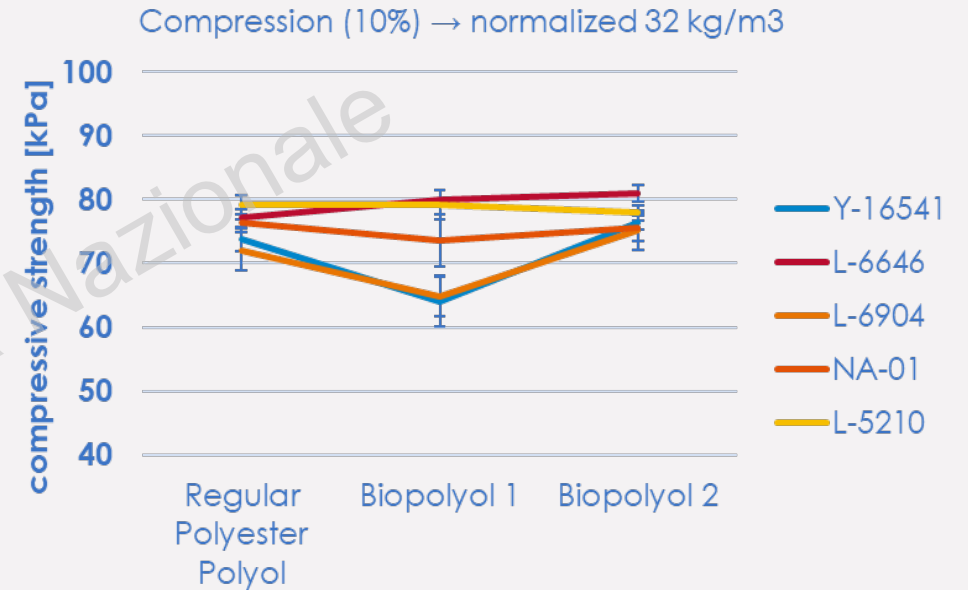
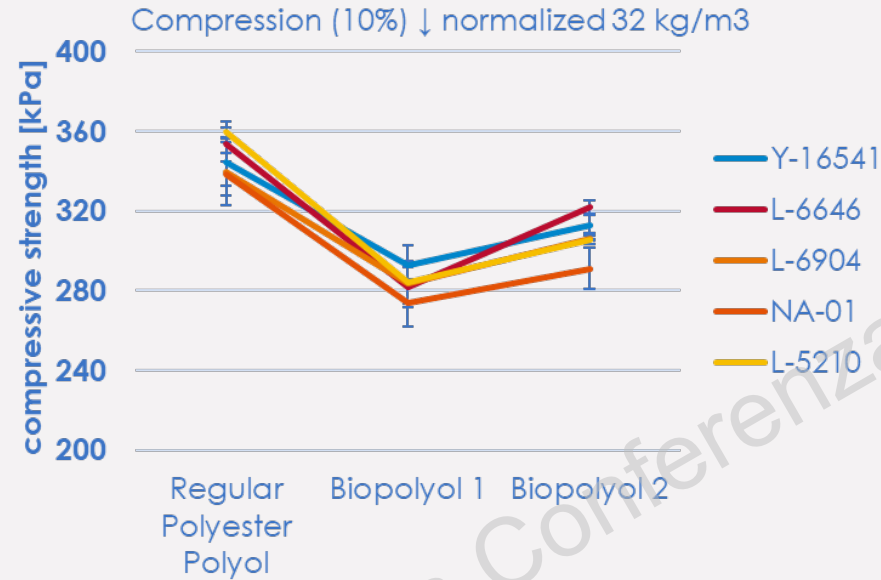
FORMULATION 1

Free rise foams

Surfactant Level 3P*

*Except: 1.5 NA-01+3 P L-6646

Gel time: 37 sec

Density: 36 kg/m³

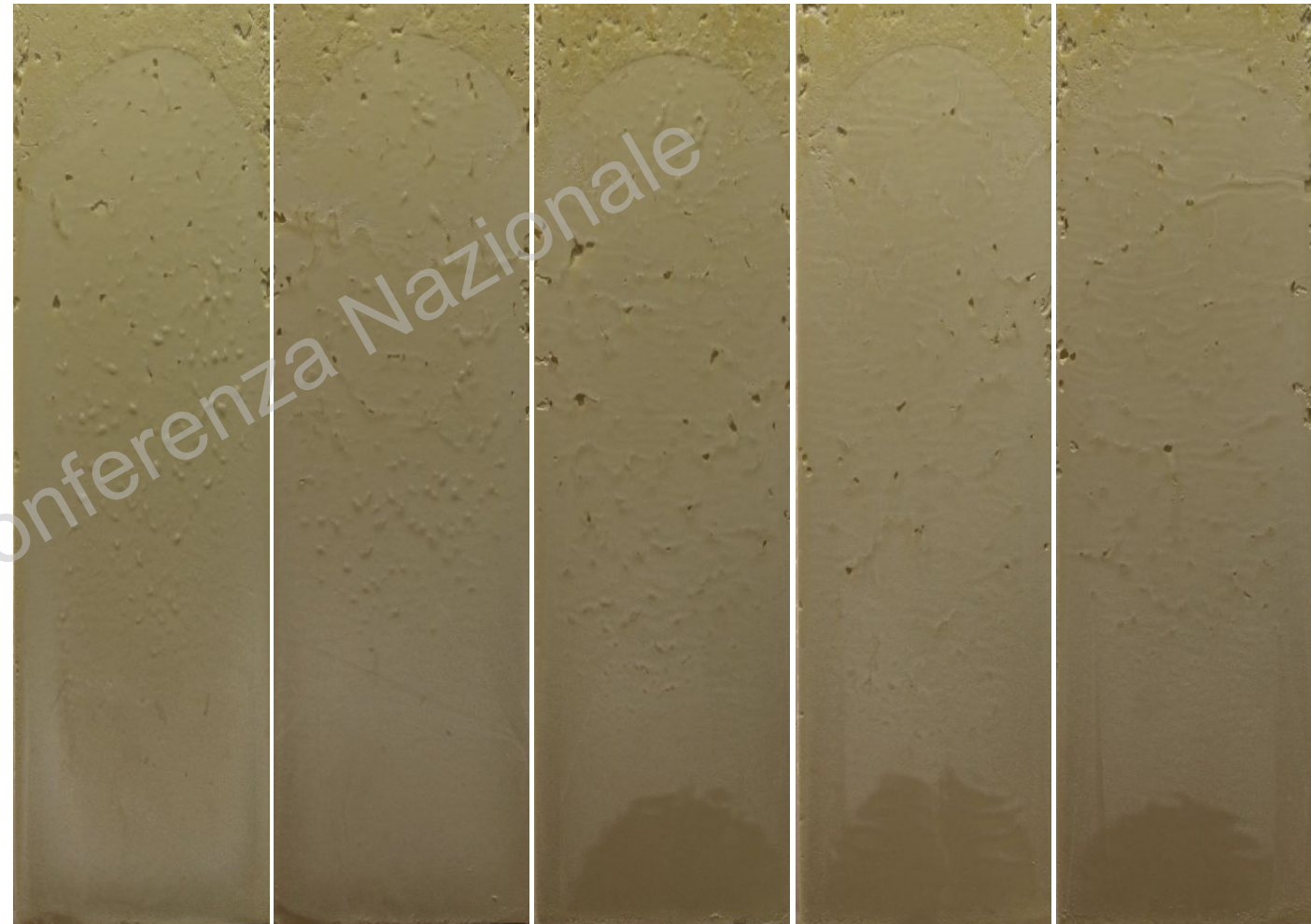
Test data. Actual results may vary.

- Compressive strength varies highly with the polyol selected.
- Niax silicone surfactant **L-6646**, **L-5210**, and **Y-16541** lead to improved compressive strengths for most foams and across the polyols tested.
- With a suitable selection of the surfactant, the foam compressive strength based on Bio-polyols can be optimized.

FORMULATION 2

Mold temperature: 45 °C

- With regular polyester polyol, Momentive surfactants enable high surface quality of the foam



L-6646

L-6904

Y-16541

+ NA-01

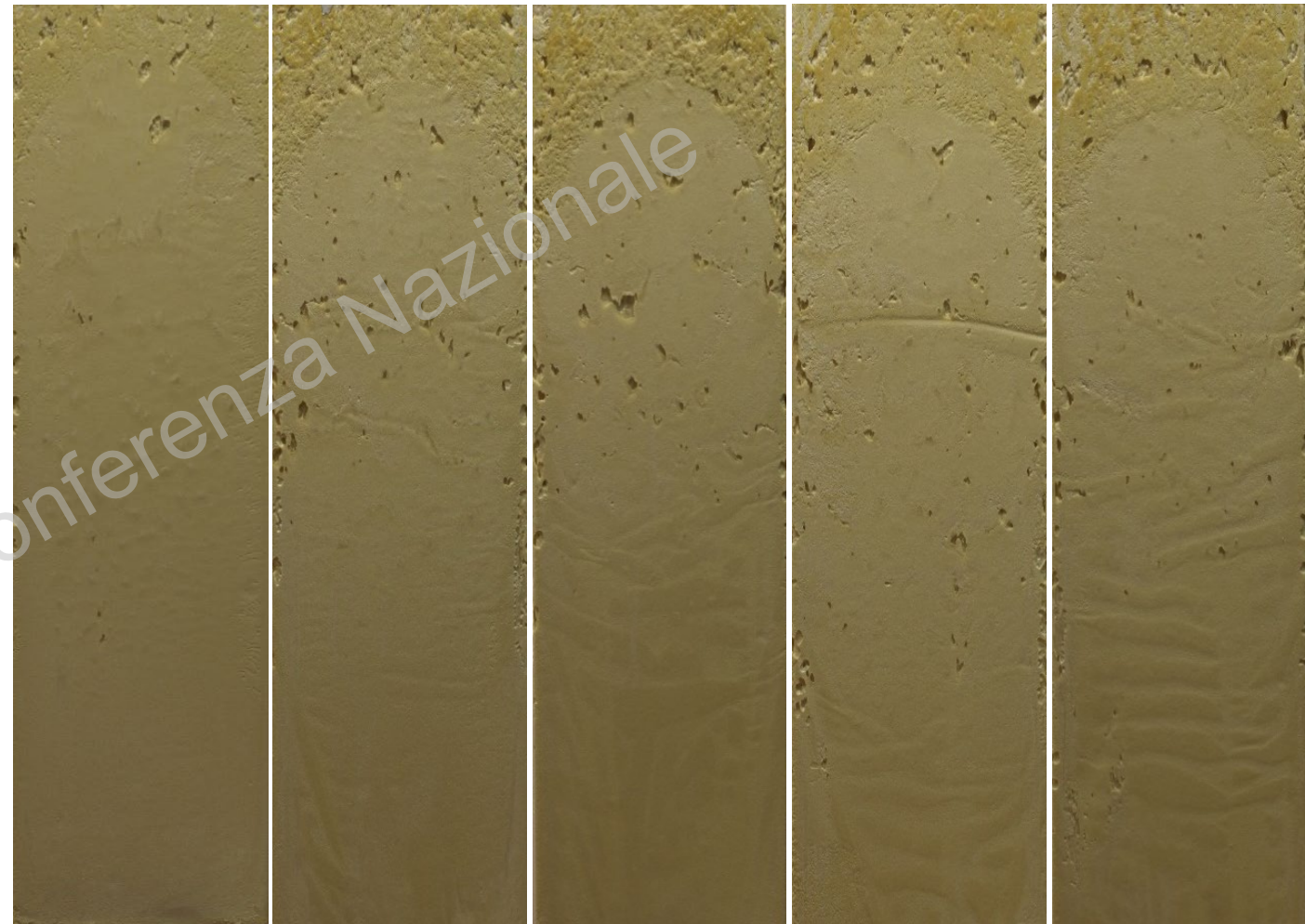
L-5210

Test data. Actual results may vary.

FORMULATION 2

Mold temperature: 45 °C

- Bio-polyol 1 shows more voids compared to the Regular polyol. The best surface quality is achieved with **Niax silicone surfactant L-6646**.
- This surfactant enables a high surface quality in Bio-based polyol formulation vs. regular polyester polyol formulations.



L-6646

L-6904

Y-16541

+ NA-01

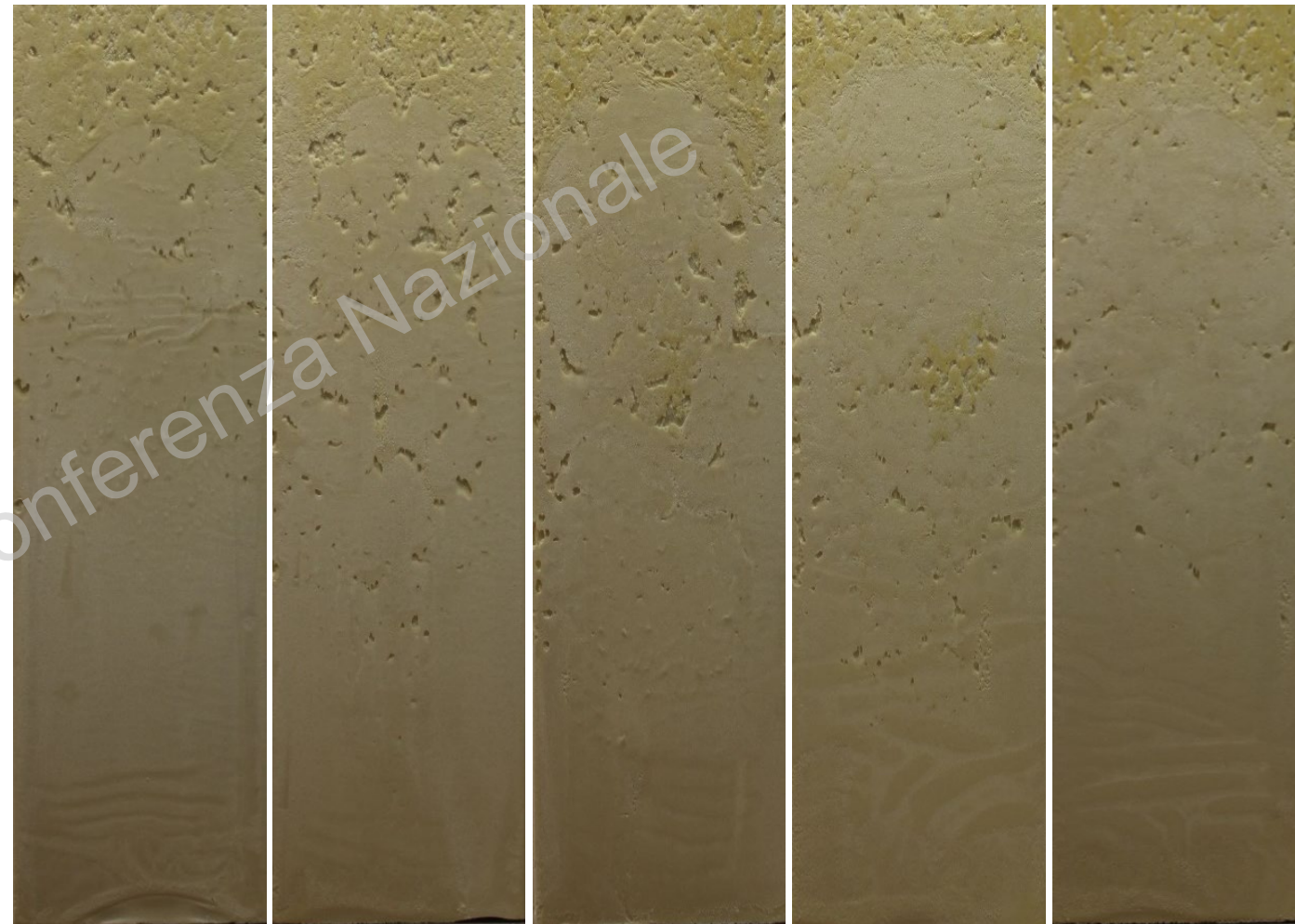
L-5210

Test data. Actual results may vary.

FORMULATION 2

Mold temperature: 45 °C

- Bio-polyol 2 confirms previous observations. It shows more voids compared to the Regular Polyol. The best surface quality is achieved with **Niax silicone surfactant L-6646**.
- This surfactant enables a high surface quality in Bio-based polyol formulation vs regular polyester polyol formulations.



L-6646

L-6904

Y-16541

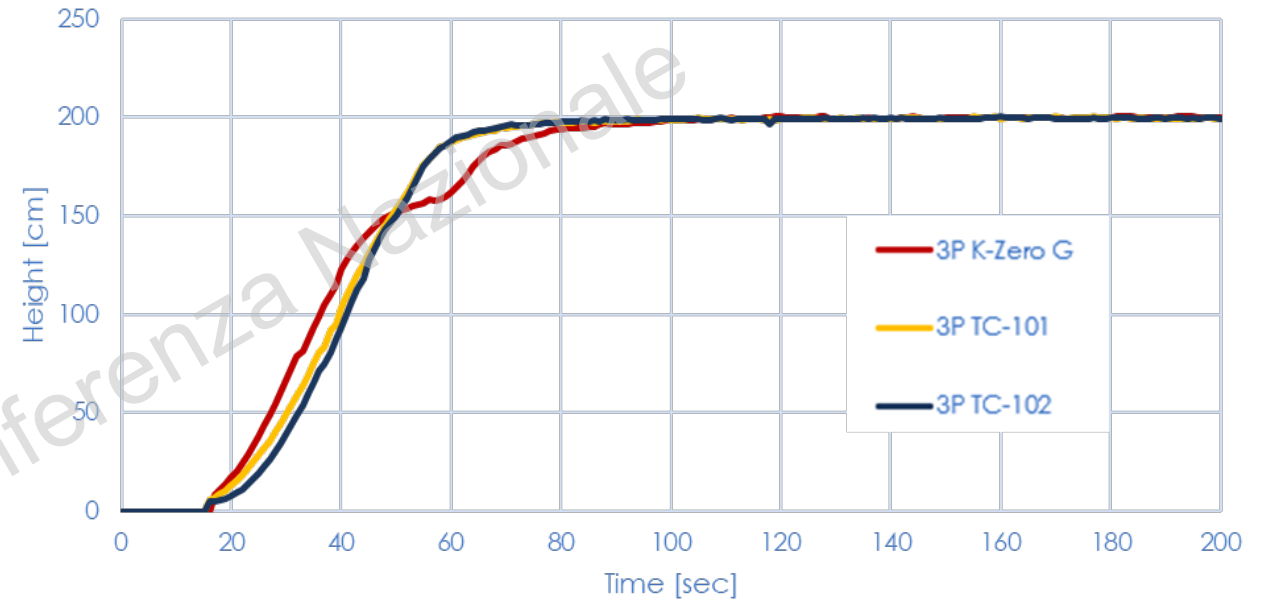
+ NA-01

L-5210

Test data. Actual results may vary.

- Niax catalyst **TC-101** and **TC-102** are highly efficient trimerization catalysts based on non-reprotoxic salts.
- Both Niax catalyst TC-101 and TC-102 have a smooth rise profile vs. K-Octoate. This can be beneficial for processing on a laminator line.
- By their higher trimer efficiency, Niax catalyst TC-101 and TC-102 result in faster tack free times when used at the same level.
- Niax catalyst TC-101 is based on a diluent phase with lower OH value in comparison with Niax catalyst TC-102.

Free Rise Profile

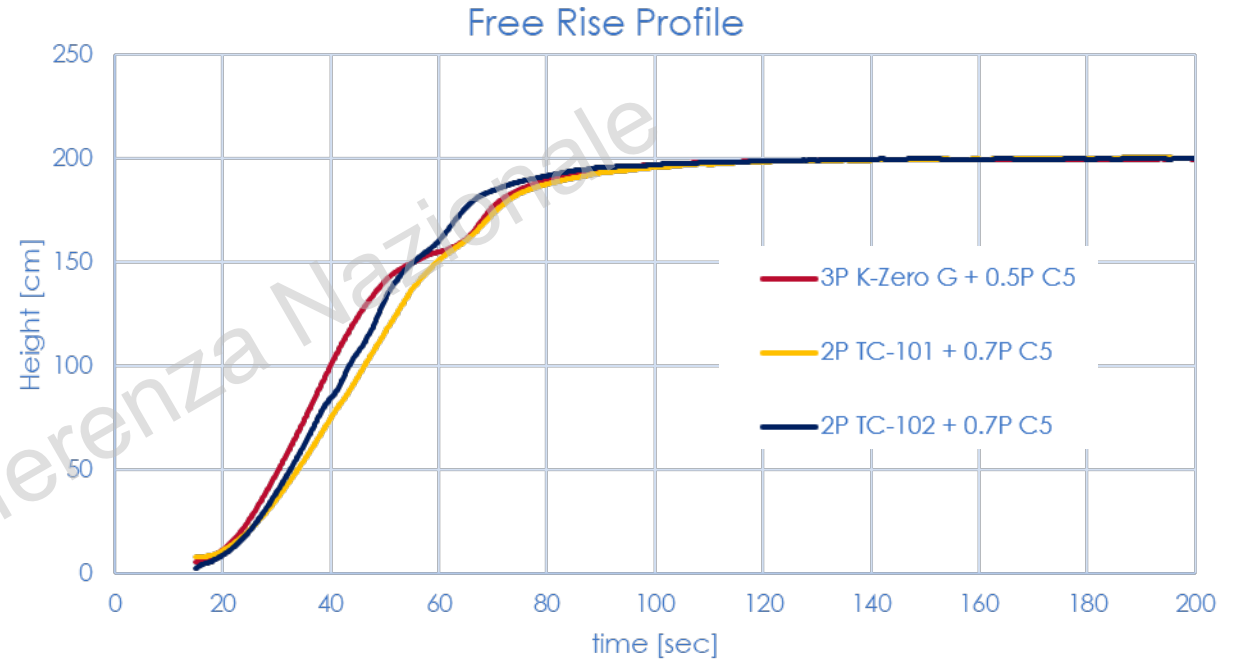


	3P K-ZERO G	3P TC-101	3P TC-102
Gel Time [sec]	48	50	50
Tack Free Time [sec]	118	95	93
Density [kg/m³]	34.6	33.2	34.1

Test data. Actual results may vary.

Sustainable Trimer Catalyst for PIR Rigid

- A controlled end cure may be required for optimum processing. Reducing the trimer catalyst level while increasing the amine catalyst can be an approach to achieve it.
- Such adjustment maintains a smooth rise profile and delivers cure at a timing to best suit particular production line characteristics.
- It may result in a gel time closer to end of rise and a delayed cure/tack free time, which can be beneficial to foam processing.
- Overall, a **significant reduction** of Niax **trimerization catalyst TC-101 and TC-102** can be practiced. Actual level will require optimization for specific formulations and industrial conditions.



	3P K-ZERO G 0.5 P C-5	2P TC-101 0.7 P C-5	2P TC-102 0.7 P C-5
Gel Time [sec]	48	60	56
Tack Free Time [sec]	118	135	128
Density [kg/m³]	34.6	35.2	34.4

Test data. Actual results may vary.

HOW CAN MOMENTIVE ENABLE **SUSTAINABLE** **SOLUTIONS** FOR YOUR **RIGID** **FOAM** PRODUCT?

This work showed how Momentive additives can improve rigid foam formulations used for insulation panels, and more specifically how new Niax silicone surfactants can enable the use of Bio-polyols and improve their final foam properties.





- **Niax silicone L-5210** is a **high purity surfactant*** and gives **lower thermal conductivity** due to its enlarged nucleating properties.
- In applications with strong demands on voids control, **Niax silicone L-6646** is an excellent candidate to offer **high quality foam surfaces** while retaining thermal conductivity at appropriate levels. It is also designed to be a **high purity surfactant***.
- **Niax silicone L-6904** and **Y-16541** result in overall balanced foam properties and are also high purities surfactants.
- A nucleating additive **Niax silicone NA-01** is proposed to lower the foam thermal conductivity as it showed to be effective both with a regular control polyol and with selected Bio-polyol grades.
- **Niax TC-101** and **TC-102** are trimerization catalysts based on a non-reprotoxic K salt, that offer a higher trimer conversion efficiency and a smoother rise profile compared with Potassium Octoate.

* High purity surfactants minimize the level of residual compounds, especially cyclic siloxane structures (D4,D5,D6), each below 1000 ppm.

ACKNOWLEDGEMENTS

Scan the qr codes
to download the
brochures!



NIAx
ADDITIVES
BY MOMENTIVE

ALWAYS ONE
STEP AHEAD

EMEAI EUROPE, MIDDLE EAST, AFRICA & INDIA

POLYURETHANE ADDITIVES FOR
**METAL PANELS
CONTINUOUS
LAMINATION**



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POLYURETHANE ADDITIVES FOR
**INSULATION
BOARDS & BLOCKS
CONTINUOUS
LAMINATION**



CONTACT US:

commercial.services@momentive.com

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