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SOLUTIONS FOR A SUSTAINABLE WORLD™

NIAX ADDITIVES BY MOMENTIVE

SILICONE SURFACTANTS TO ENHANCE THE PERFORMANCE OF POLYISOCYANURATE RIGID FOAMS

Presenter: Dr. Christy Chan

ANPE 2024 – May 30th, 2024

Sustainable Solutions

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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Who We Are

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

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Business Units Overview

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***

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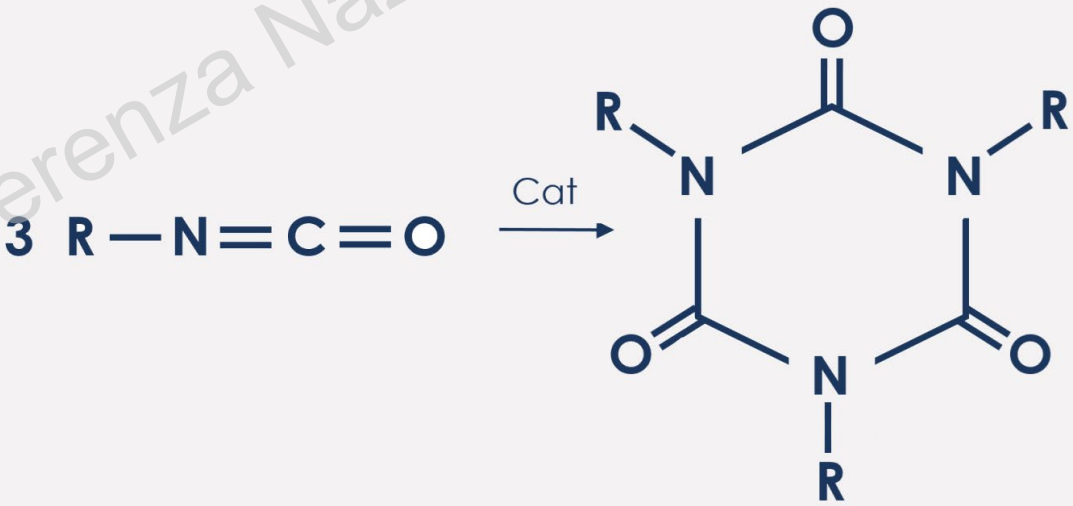
Where And How They Are Used

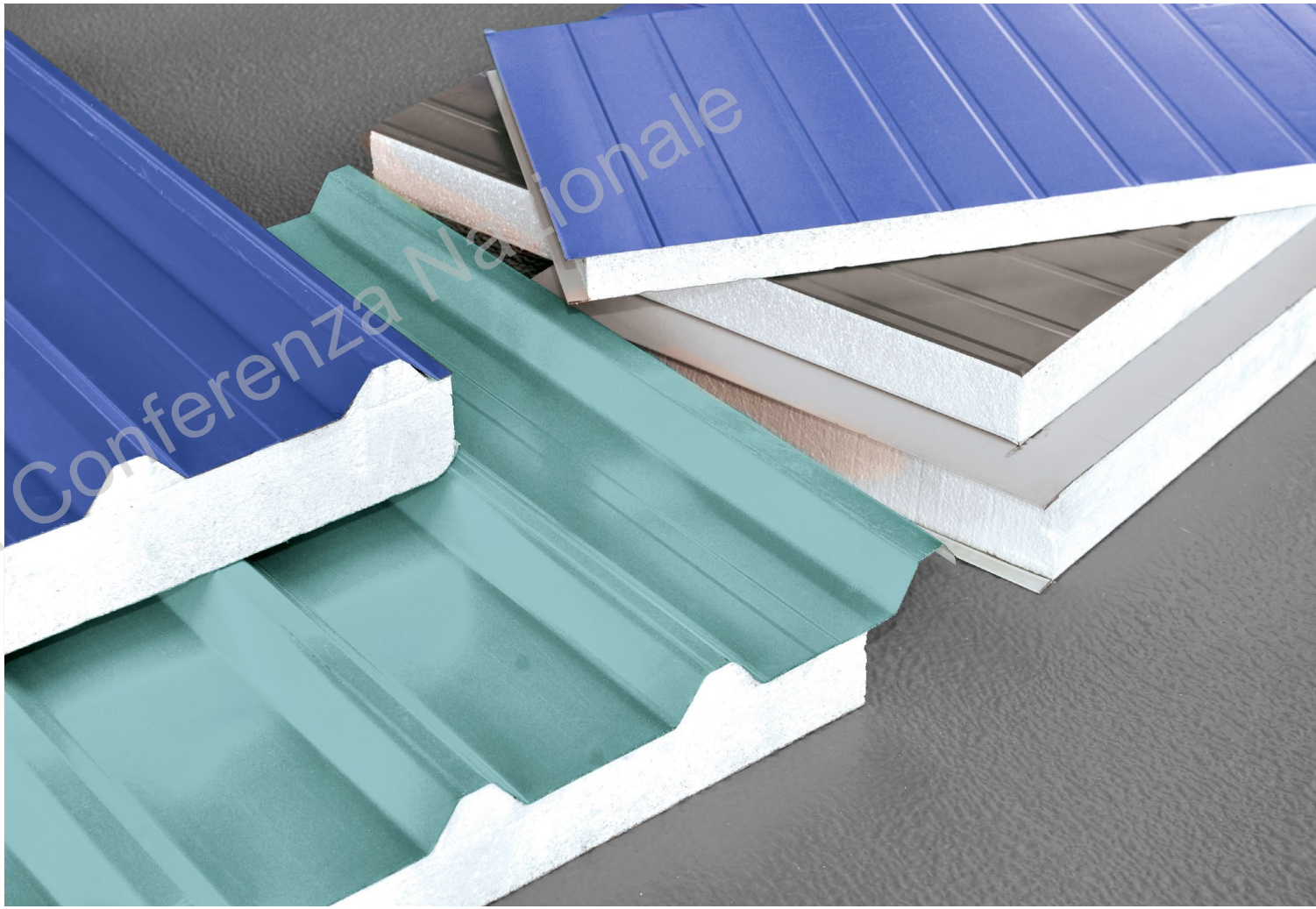
- A formulation category designed for the production of rigid foams by using an excess of isocyanate to generate **isocyanurate** bonds. These contribute to a higher foam FR performance.

- The **dominant formulation/foam type** as core material of insulation panels produced by **continuous lamination** (excellent performance and an attractive set of processing benefits).



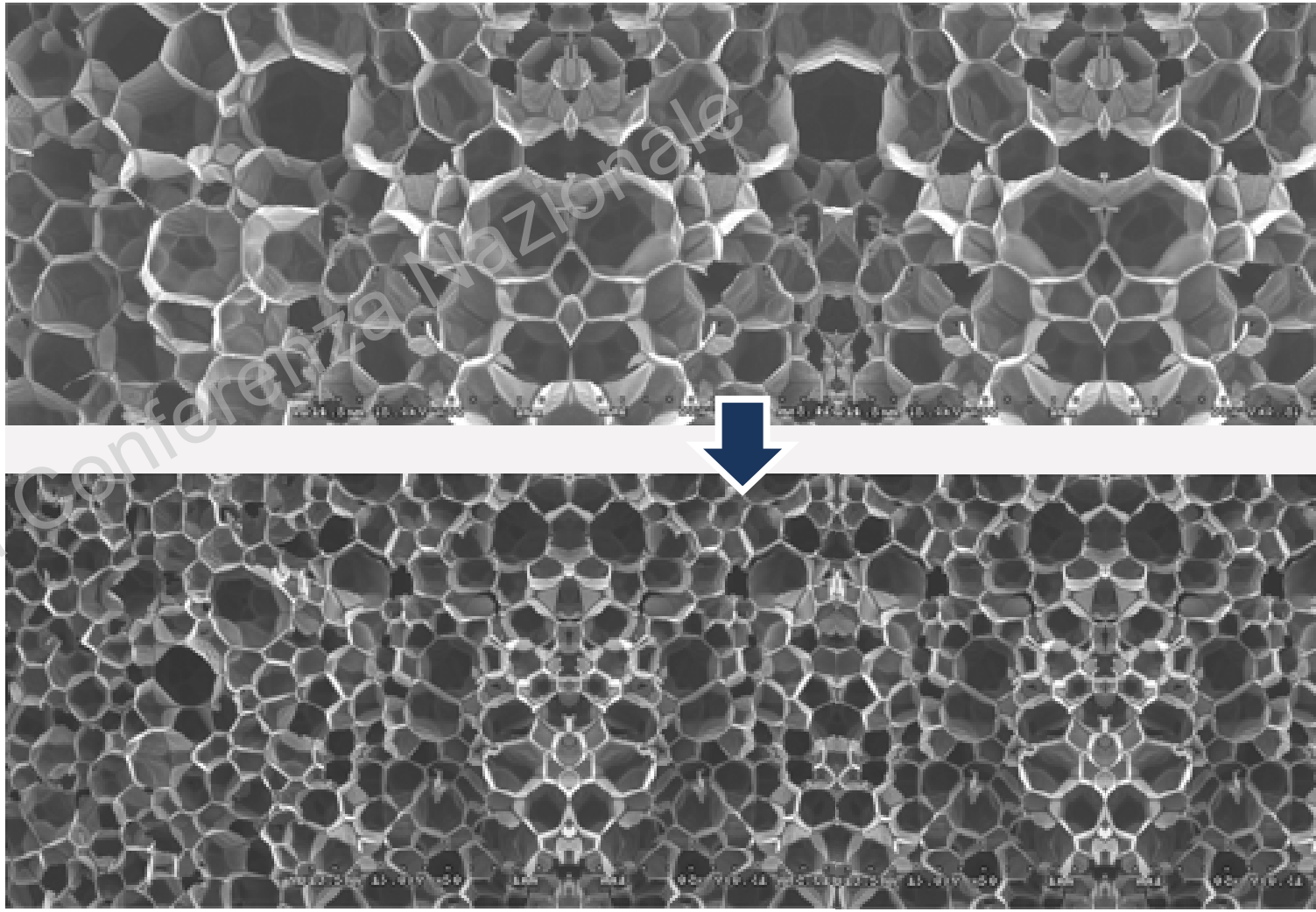
Where And How They Are Used

- 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.



Where And How They Are Used

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



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How Does The Surfactant Help Thermal Insulation?

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

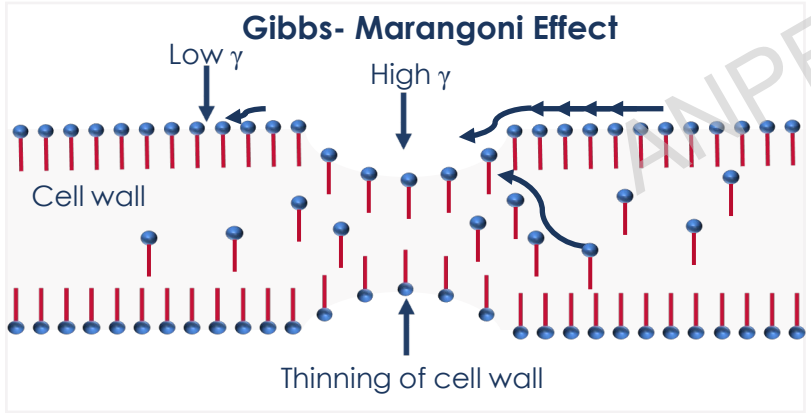
Overall foam thermal conductivity

The lower, the better
(= high thermal insulation)

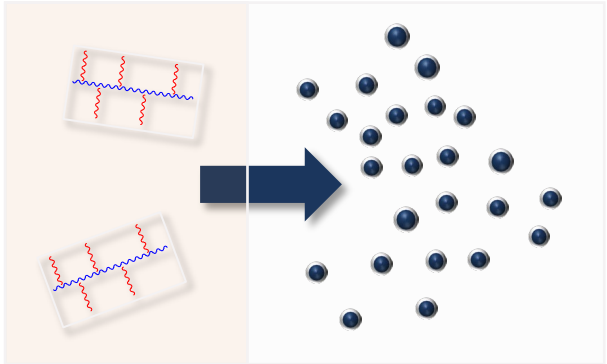
Small cell size

SURFACTANT

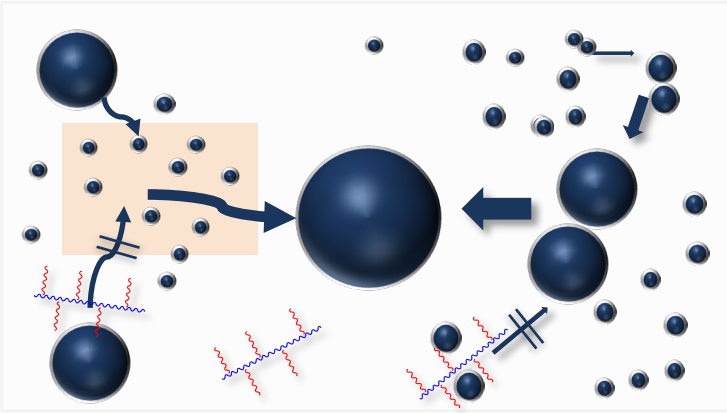
Maintain cell wall elasticity



***Nucleation*, leading to fine cells**



Cell growth by Ostwald ripening and coalescence effect



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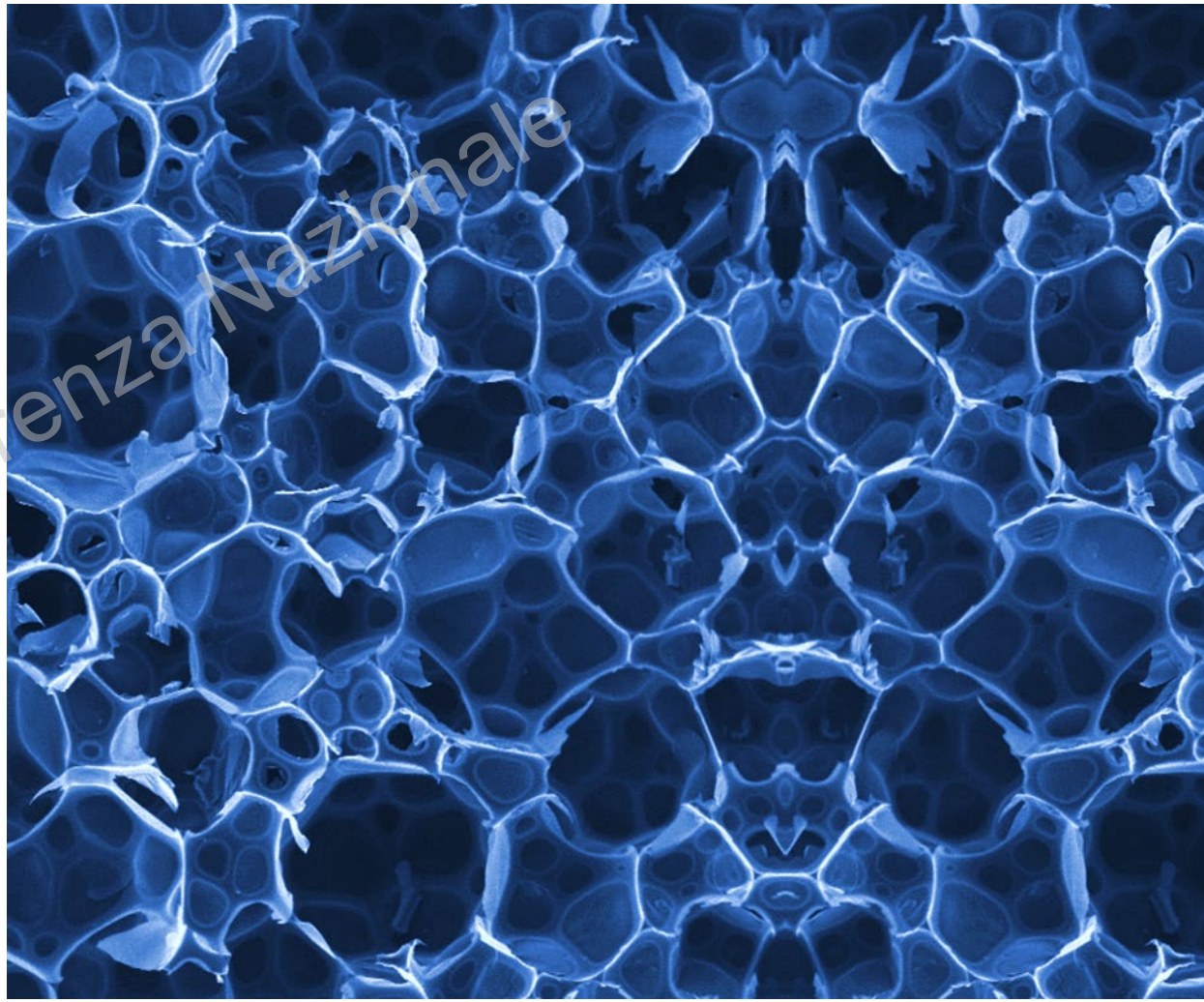
Development of New Grades

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

FORMULATION 1

FORMULATION 2

FORMULATION 3



Development of New Grades

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/m^3
- 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

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Development of New Grades

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/m^3
- 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

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Development of New Grades

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/m^3
- 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

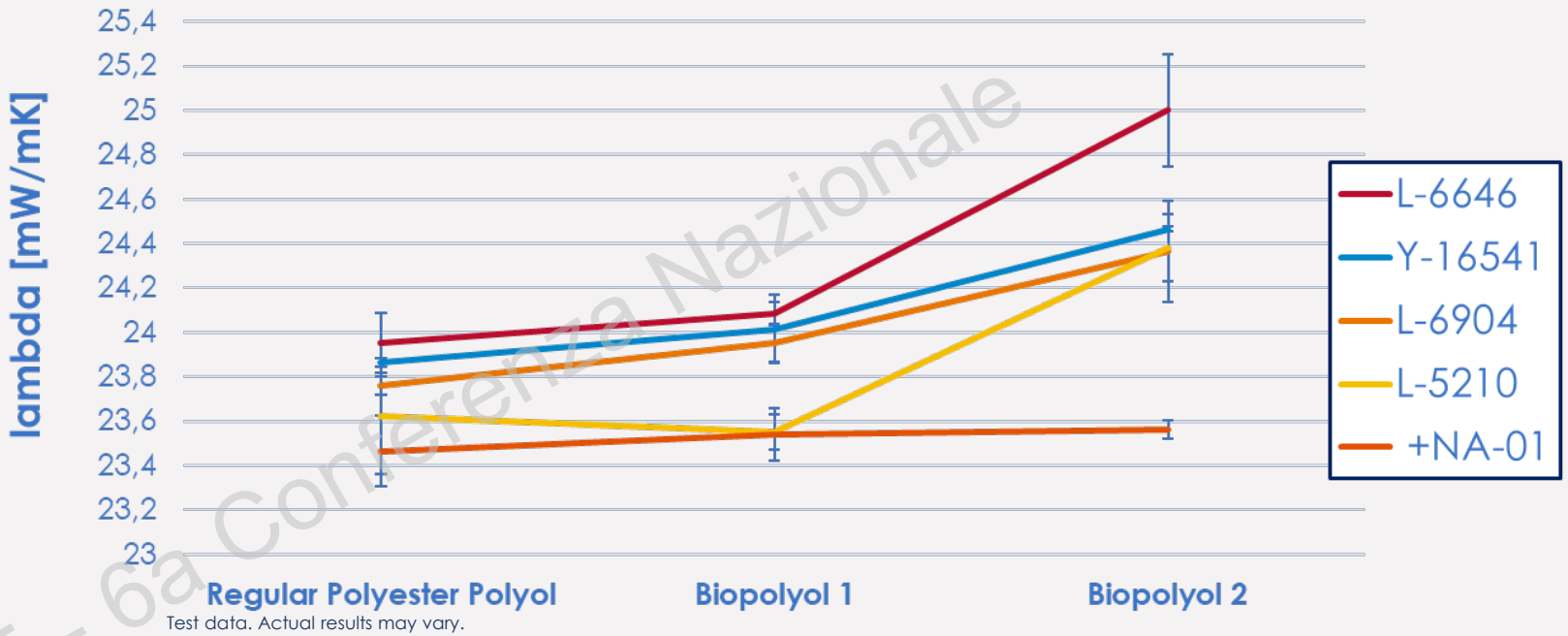
Thermal Conductivity

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/m^3



Test data. Actual results may vary.

- 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.

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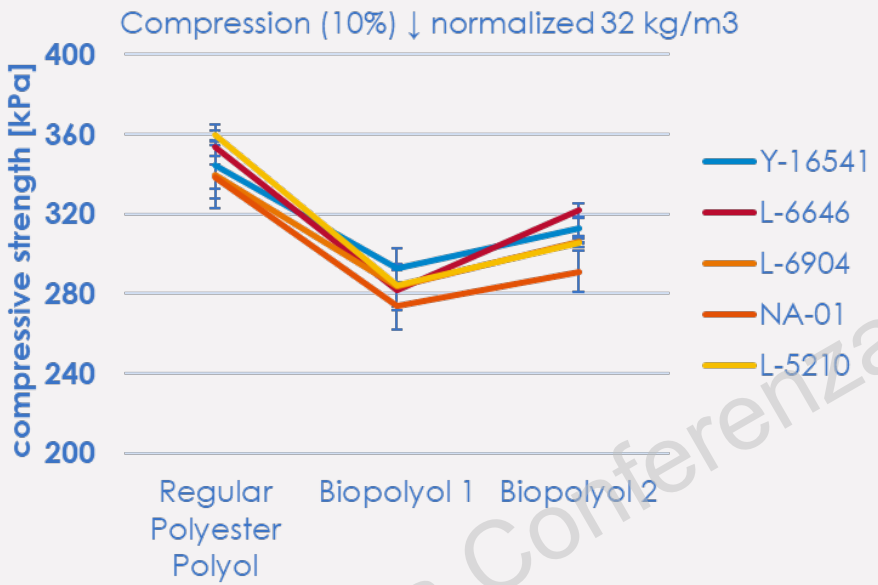
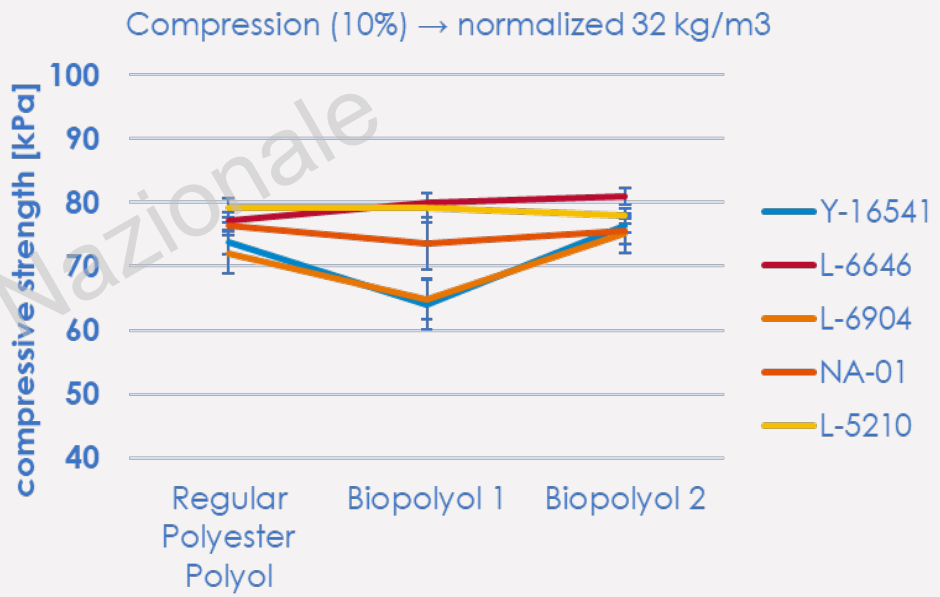
Mechanical Properties: Compressive Strength

FORMULATION 1

Free rise foams
Surfactant Level 3P*
*Except: 1.5 NA-01+3 P L-6646

Gel time: 37 sec
Density: 36 kg/m^3





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.

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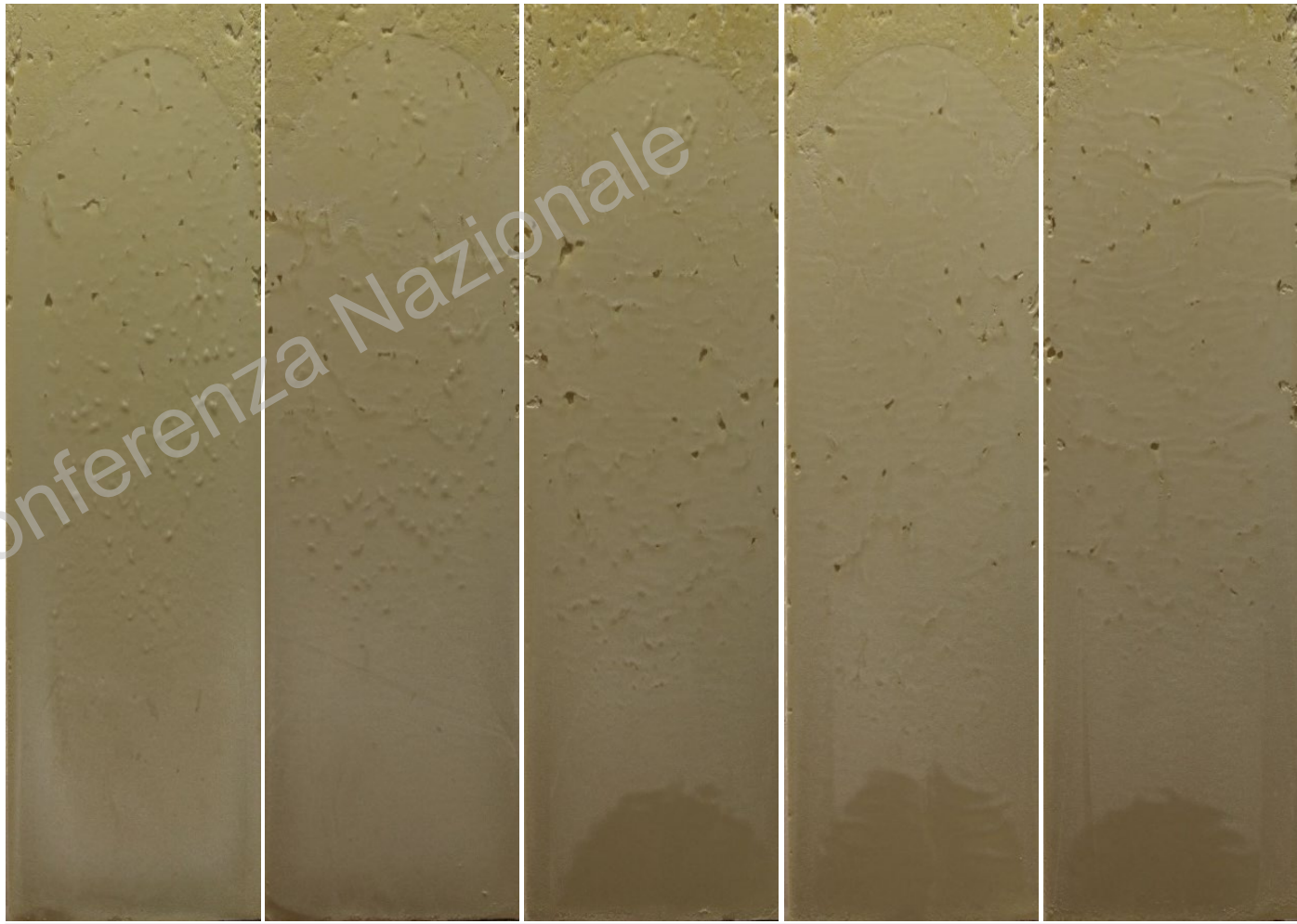
Regular Polyol

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.

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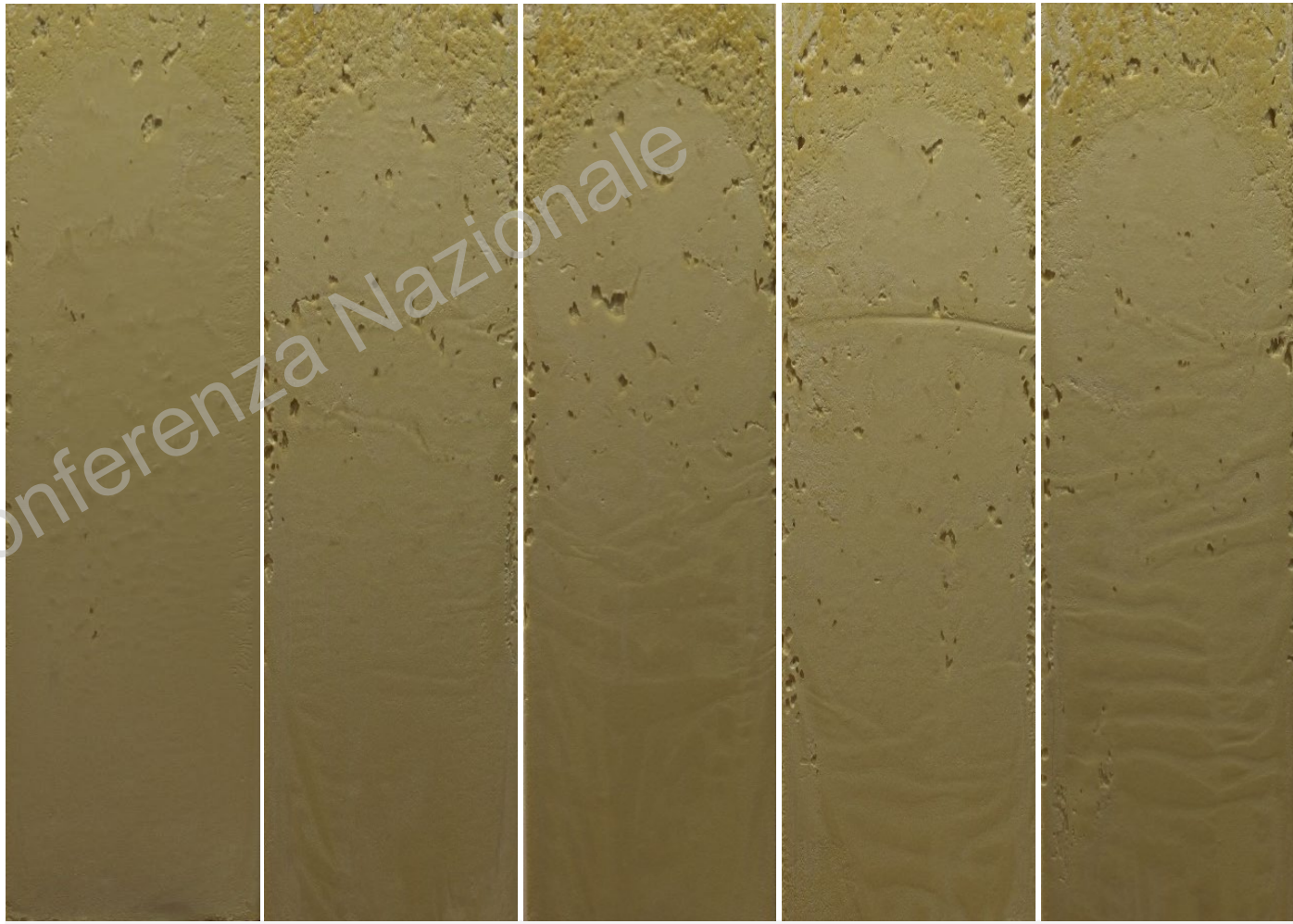
Bio-Polyol 1

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.



Test data. Actual results may vary.

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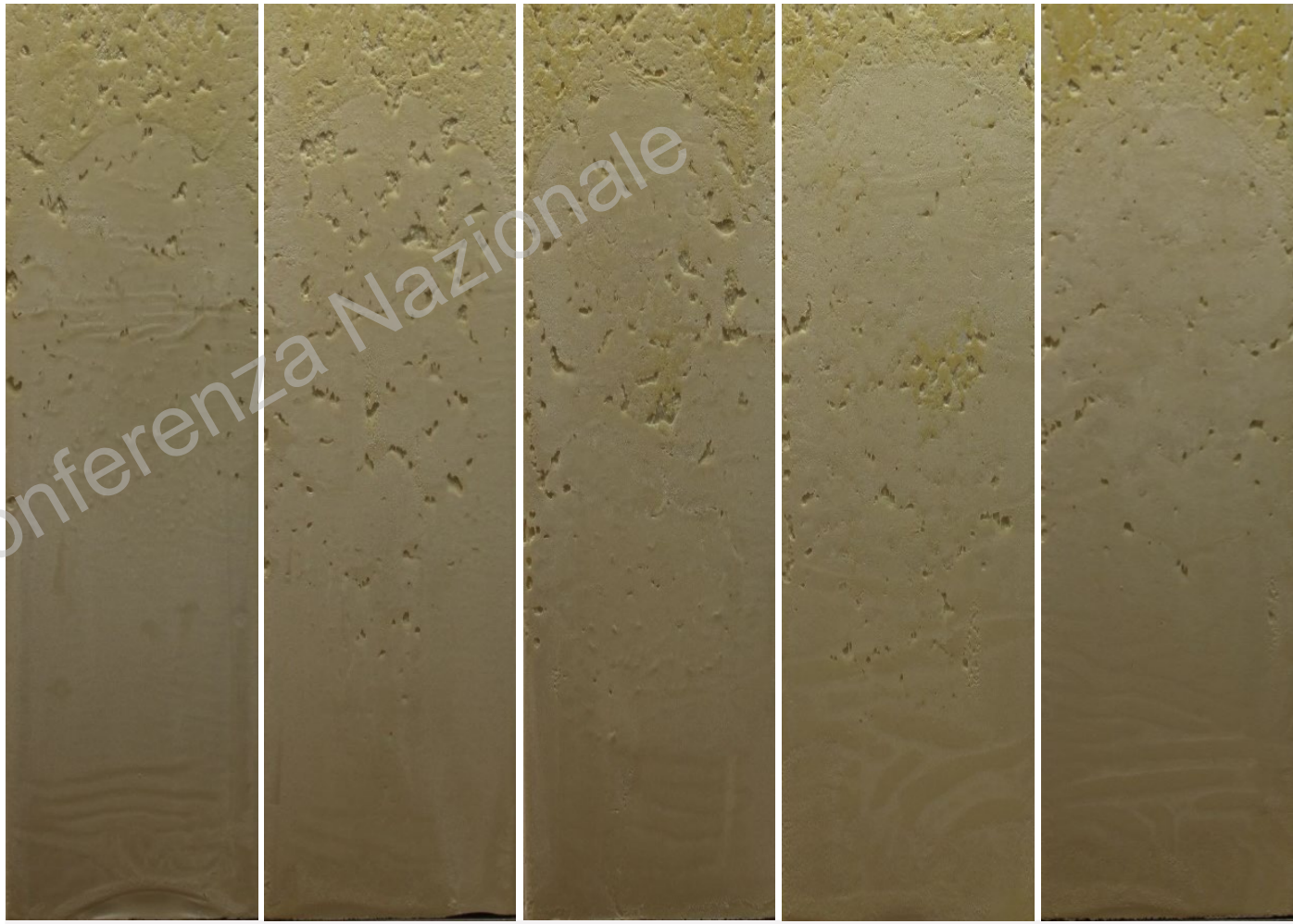
Bio-Polyol 2

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.

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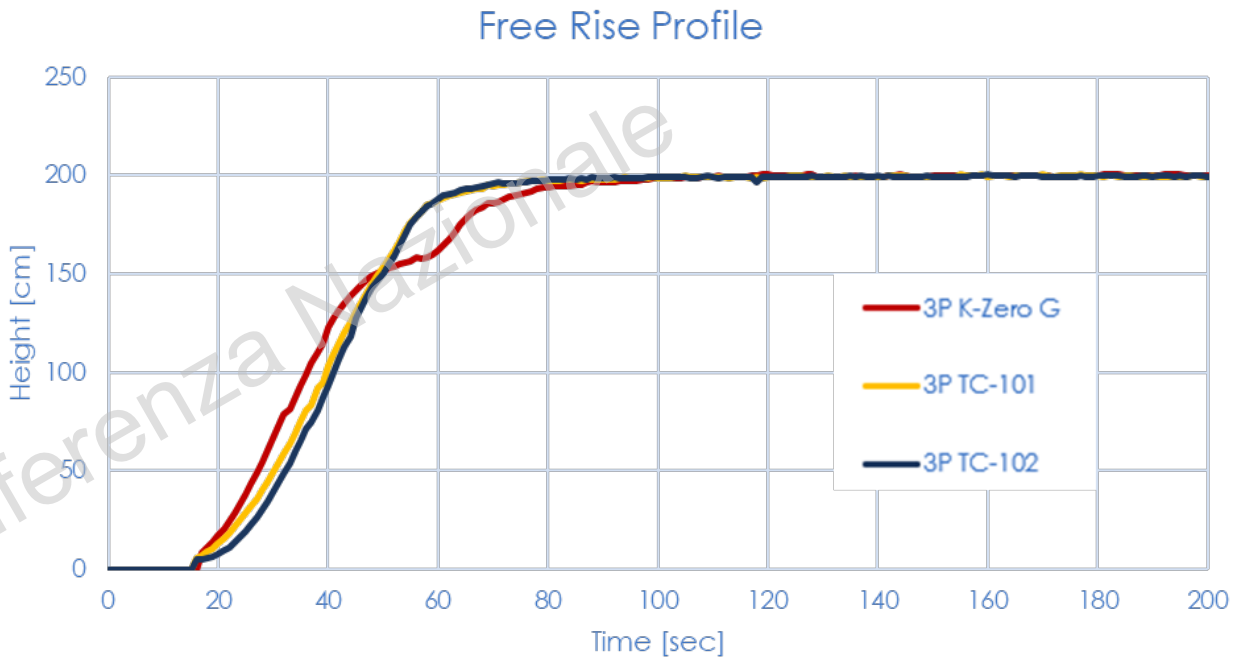
Sustainable Trimer Catalyst for PIR Rigid

- 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.



	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.

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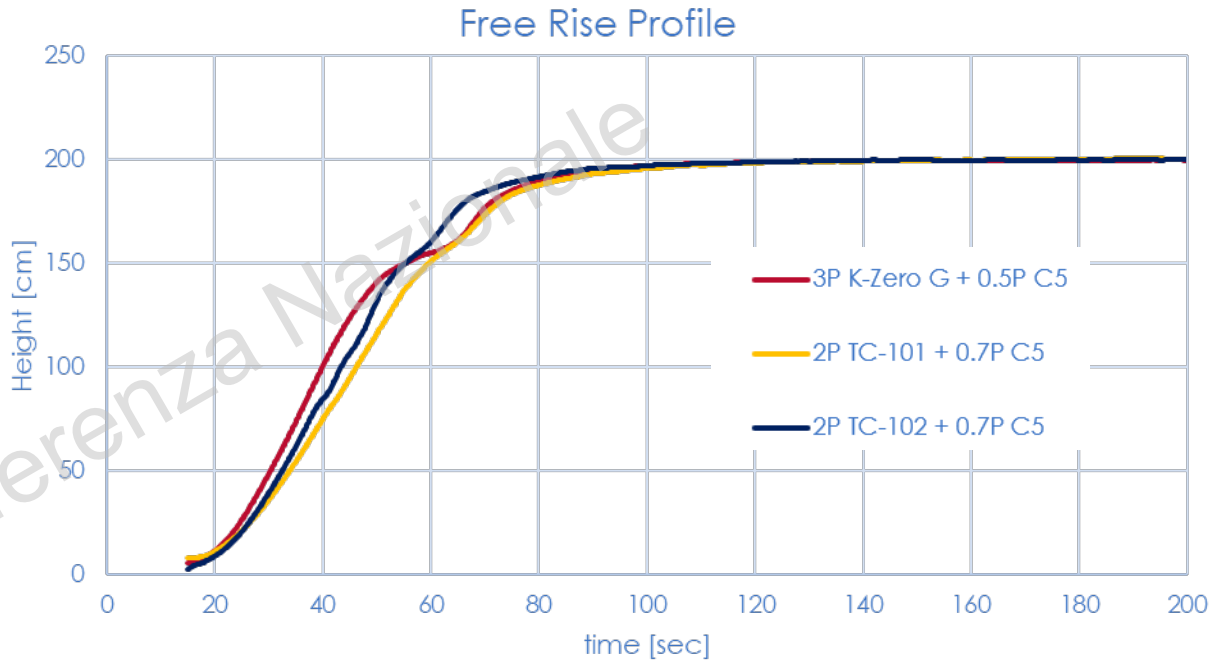
Sustainable Trimer Catalyst for PIR Rigid

- 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/m^3]	**34.6**	**35.2**	**34.4**

Test data. Actual results may vary.

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Summary And Conclusion

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.

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Summary And Conclusion

- **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.

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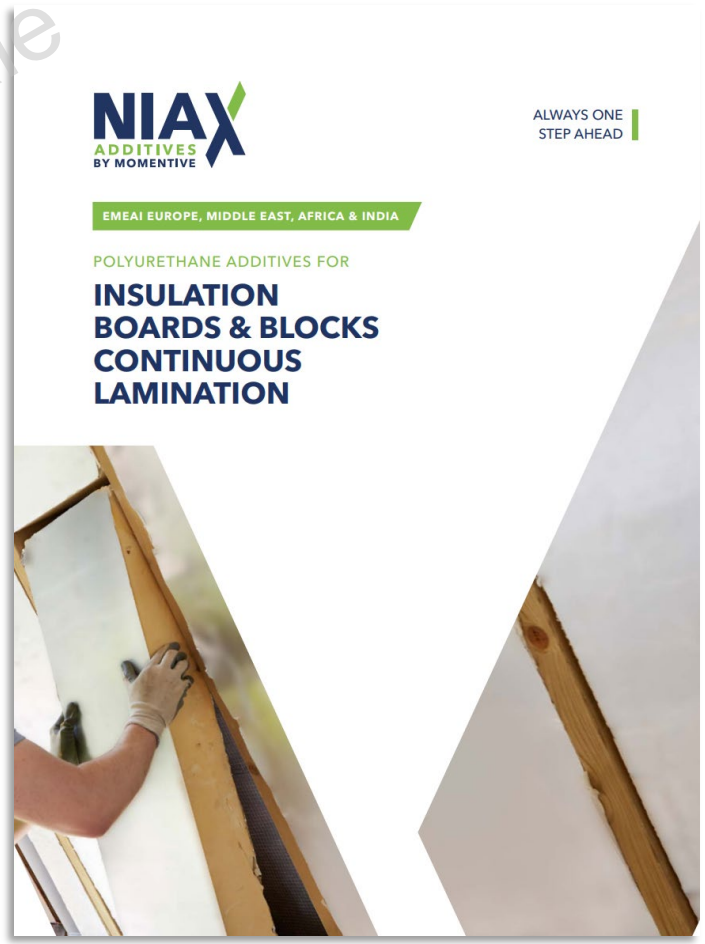
ACKNOWLEDGEMENTS

Scan the qr codes to download the brochures!



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THANK YOU!

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