2K Bio-Based Functional and Renewable PUD for OEM

Presenter: Anja Kloth, Lubrizol Deutschland GmbH

OCTIMA Conference “Wood Finishing: Raw Materials for the Formulation of Next-Generation Coatings and varnishes“ Milan, October 28, 2026

Lubrizol

Imagined for Life. Enabled by Science.™

© 2025 The Lubrizol Corporation. All rights reserved.

Agenda

- Europe’s wood coatings: drivers of change
- Sustainable design, built for performance
- Smarter crosslinking: bio-based PUDs for 2K NISO
- High solids for greater application efficiency
- Proof in performance: wood-floor test results



Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

Lubrizol Confidential

Wood Coatings Market Europe

© 2025 The Lubrizol Corporation. All rights reserved.

Wood Coating Market Europe

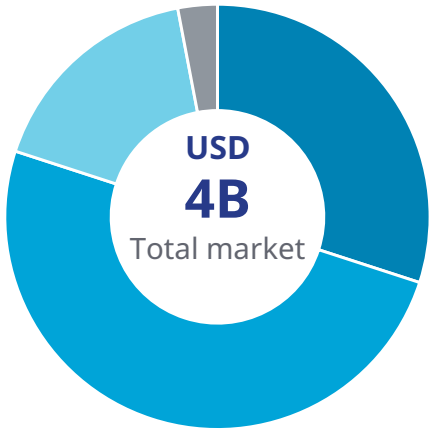


Est. USD 3.5 - 4B

4-5% CAGR

Market mix by technology

Estimated 2025 share of wood coating market



- **Water Based** **50%** **US$2B**
  Fastest-growing conversion route
- **Solvent Based** **30%** **US$1.2B**
  Dominant but under pressure
- **UV-Cured** **17%** **US$0.7B**
  Flooring, panels & high-speed lines
- **Powder** **3%** **US$0.1B**
  MDF & low-temp curing opportunities

Water-based is the growth lane; solvent remains under pressure: defend; UV and powder offer focused application opportunities.
In Europe, technology adoption is increasingly driven by VOC compliance, indoor air quality requirements, decarbonization targets and customer sustainability commitments, while performance remains the primary qualification critertion

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.
Lubrizol Confidential

What drives adoption in Europe?



Regulatory Pull

Reduced VOCs and hazardous regulated substances like Isocyanate remain important criteria; EU Ecolabel now also covers performance coatings. ESG scores

Customer Specification

Furniture, flooring and building value chains increasingly ask for durability together with credible environmental claims.

Decarbonization

Bio-based content, high solids, lower fossil-resource use and LCA transparency support Scope 3 reduction discussions

Technology Readiness

Waterborne, 1K self-crosslinking, UV / waterborne UV and high-solids routes must fit existing application lines.

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

Confidential

Sustainable design, built for performance

© 2025 The Lubrizol Corporation. All rights reserved.

Sustainable design: Functional Polyurethane Dispersion - NISO

Develop a polyurethane dispersion for high-performance sustainable coatings



Performance

Extended durability

2-component formulation
Chemical resistance
Mechanical properties

Design focus: PROTECTION



Sustainability

Lower-impact formulation

Low MFFT for low VOC
Plant-based raw materials
Isocyante-free crosslinkers
High solids

Design goals: indoor air quality and REDUCED CO_2 EMISSIONS



Efficiency

A simpler paint process

Optimized reactivity
High solids
Lower total applied cost
Faster return to service

Design goals: Manufacturing & Application EFFICIENCY

Lubrizol

© 2026 The Lubrizol Corporation. All rights reserved.

Lubrizol Confidential

Sustainable design, built for performance

Innovation

HO- -OH
Polyol
(Soft segment)

OCN- -NCO
Poly-Isocyanates
(Hard segment)

HO- -OH
Acid
(Water dispersing)

Diluent
Process Aid
(viscosity control)

Sustainability-Focused

1 Composition-first design

Polyamide polyol and soft / hard segment balance create the performance base: mechanical strength, hydrolytic stability and chemical resistance.

Composition → performance

2 Optimized morphology

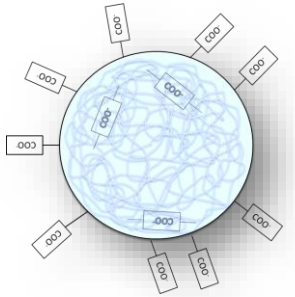
Acid content and dispersing architecture shape particle morphology so reactive groups remain accessible and effective acid number increases.

Morphology → reactivity

3 Effective crosslinking

Accessible NISO-reactive groups, higher effective acid number and lower MFFT enable robust crosslinking and final coating performance.

Effective crosslinking



Optimized morphology

Approach: start with polyurethane composition to control morphology, maximize reactive-group accessibility and secure final performance.

Lubrizol

© 2026 The Lubrizol Corporation. All rights reserved.

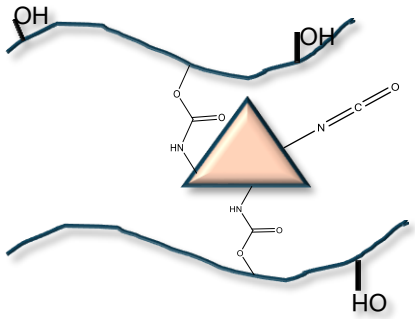
Confidential

Smarter crosslinking: bio-based PUDs for 2K NISO

Innovation

Traditional crosslinking routes

Isocyanate

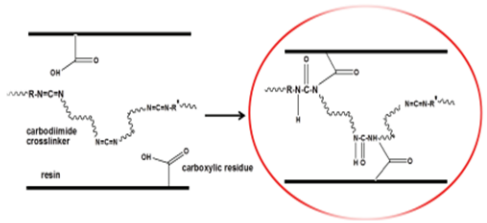


Crosslinks hydroxyl (–OH)

PROS
High reactivity
Strong performance

CONS
Hazardous identification
HSE handling burden

Carbodiimide

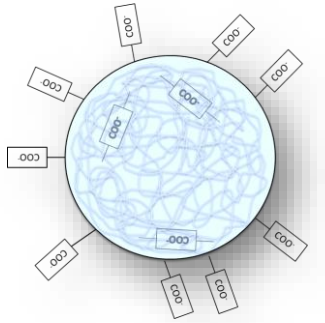


Crosslinks carboxyl (–COOH)

PROS
Low toxicity
Environmentally friendlier

CONS
Poor reactivity
Limited performance uplift

New technology



How APTALON solves the gaps

Accessible reactive groups
Easier for carbodiimide to react.

Higher reactivity & efficiency
Addresses the current drawback.

Improved performance
Closes the gap to isocyanates.

New Technology addresses carbodiimide drawbacks: better access, higher reactivity and stronger performance

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

Lubrizol Confidential

High solids for greater application efficiency

Develop a viable urethane **PRODUCTION PROCESS**:

✓ Define compositional and process boundaries of new technology targeting… **HIGH SOLIDS PUD**

Traditional PUD



VS

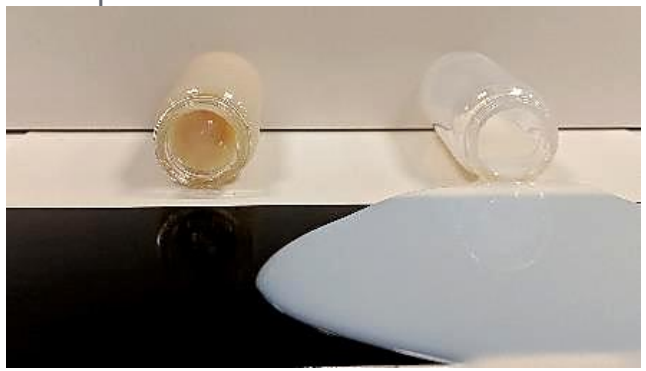
High Solids PUD



After 4 weeks at 50°C

High solids commercial product

Our high solids polyamide PUD



SOLID **STILL FLOWABLE**

Key Benefits

- Freight and packaging cost savings. Transport >35% more resin and less water.
- Improved productivity and better application efficiency
- CO_2 emission reduction-freight and manufacturing
- Enables higher film build
- Quicker drying saving labor times

Improve productivity and application efficiency

Lubrizol

© 2026 The Lubrizol Corporation. All rights reserved.

Confidential

Functional Bio-Based PUD for 2K NISO Systems



New technology

Functional PUD with carboxy functionality

Efficient NISO crosslinking delivering 2K-level performance

Bio-based

Low-VOC

High-solids formulations

Future-ready performance

2K performance built for today's and future regulations.



Proof of concept

2K waterborne formulation for wood floors

New PUD dispersion screened as a proof of concept.

Observed indicators

Effective crosslinking and higher effective acid number

Low MFFT for improved film formation

Higher efficiency with fewer coats required



Technology readiness

Demonstrated in relevant coating formulations

Current example: deployment-ready technology.

Evidence to add

Scale, validation, manufacturing readiness and remaining risks.

First commercial product available for sampling

Lubrizol

© 2026 The Lubrizol Corporation. All rights reserved.
Lubrizol Confidential

Proof in performance: wood-floor test results

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

PROOF OF CONCEPT

The bio-based functional PUD is a polyamide polyol-based carboxyl-functional polyurethane dispersion that is:



- Cosolvent free
- Contains 29% Bio C^{14}
- Enables low VOC formulations
- Can be crosslinked effectively with isocyanate free crosslinkers



- Is 45% Solid Content so:
  - Enables high solids formulations to improve paint process efficiency
  - Help reducing transportation carbon footprint

35% Biobased Carbon Content (as a fraction of total organic carbon). To be verified externally (ASTM D6866-18 Method B)
VOC measurements: Using European Union ISO 11890-2 / USA EPA method 24 /

© 2026 The Lubrizol Corporation. All rights reserved.

Lubrizol Confidential

Formulation and application properties

Bio-based PUD 2K carbodiimide

Commercial 2K waterborne PUD isocyanate

PROPERTY / TEST	BIO-BASED PUD 2K CARBODIIMIDE	COMMERCIAL 2K WB PUD ISOCYANATE
Paint EU VOC (g/l)	**45**	75
Number of Coats applied	**2 Coats**	3 Coats
Weight Solids, %	**42,5%**	32%
Film formation (4.4°C / 50% RH)	**Pass**	Pass
Gloss 60° (gu)	**85**	48
COF (James Machine average value)	**0.42**	0.36

Application and test conditions

Clear formulations on maple wood (unless otherwise noted). Lightly sand and wipe clean. Apply 50–75 µm wet film (2.0–3.0 mils), dry for 2 hours, lightly sand, then apply the second coat at the same rate. Air-dry panels for 7 days before testing.

Source protocol describes two coats; the commercial results in the table report three coats.

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

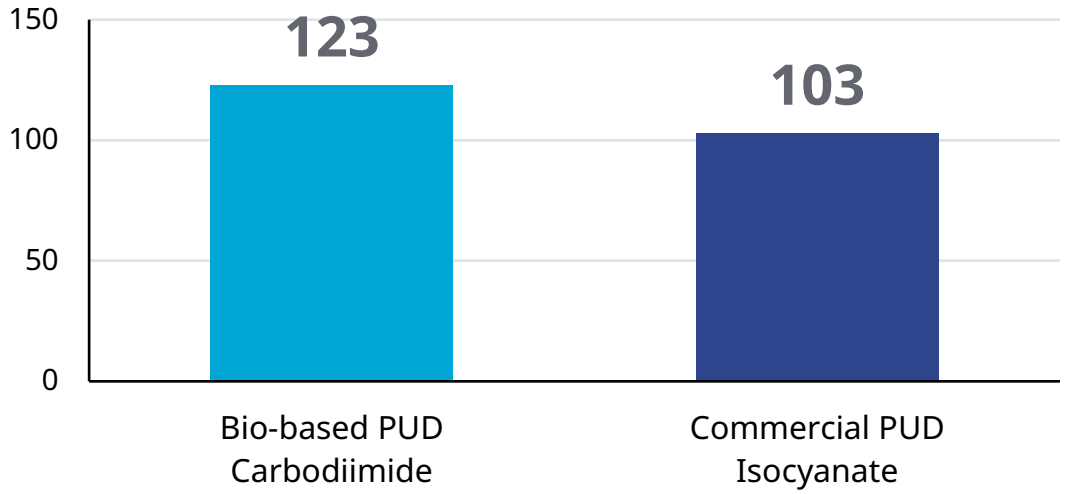
Confidential

Hardness and abrasion: two different outcomes

Bio-based PUD 2K carbodiimide

Koenig hardness

7 days, oscillations (#)



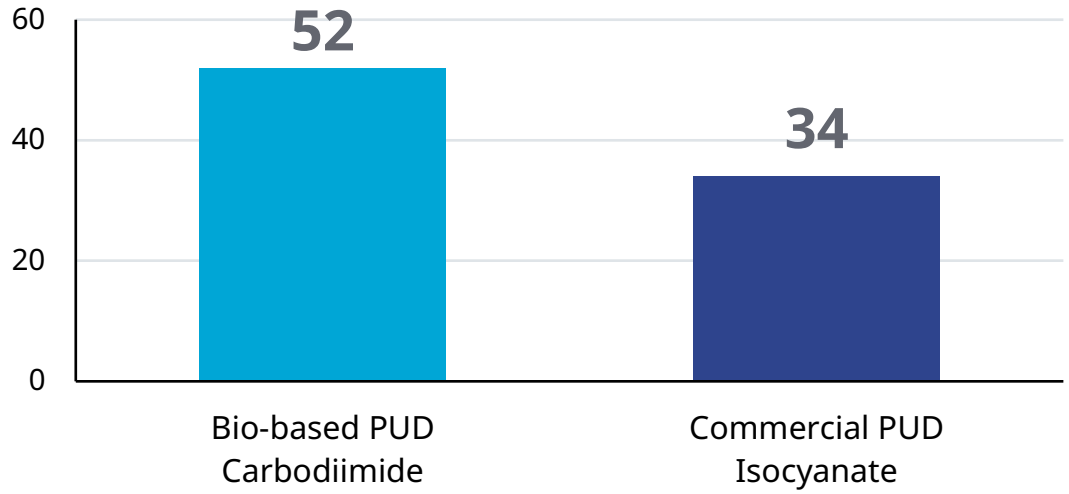
Higher hardness for the bio-based system

Commercial 2K waterborne PUD isocyanate

Taber abrasion

Average mass loss (mg), lower is better

1,000 cycles, CS17 wheels, 1,000 g load



Lower abrasion loss for the commercial system

Tested systems used different coat counts: bio-based 2 coats, commercial 3 coats. Panels air-dried for 7 days.

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

Confidential

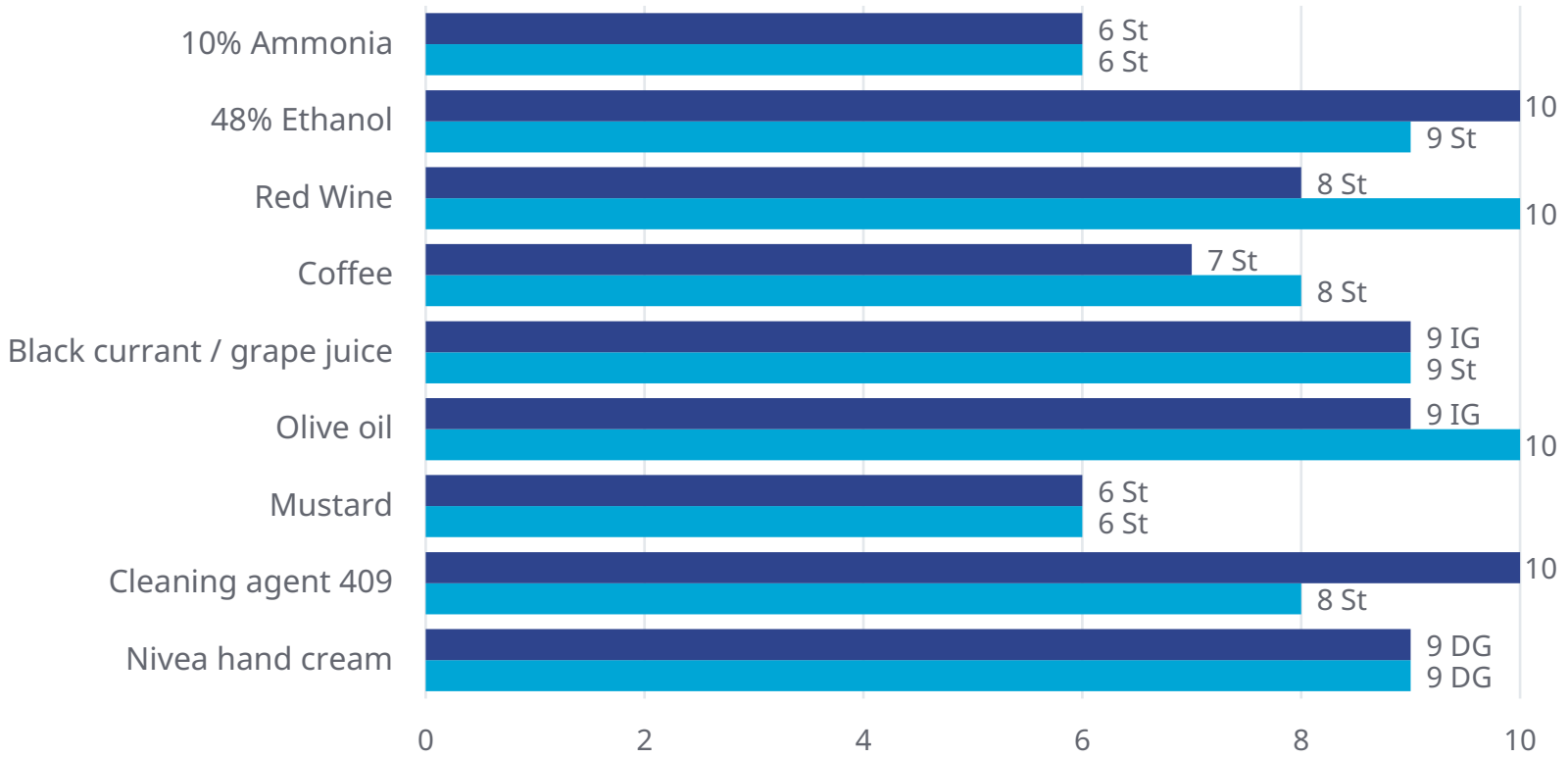
Chemical resistance: similar overall scores

Bio-based PUD 2K carbodiimide

155 / 170 total recovery score

Commercial 2K PUD isocyanate

154 / 170 total recovery score



10 / 10 for both systems

No effect after exposure

10% acetic acid
10% citric acid
Beer, cola and water
Gas and acetone
Detergent 2.5% bleach



DIN 6881. 16-hour exposure, 1-hour recovery. Ratings: 10 = no effect, 1 = strong change.
St, IG and DG: source failure-mode codes.

© 2025 The Lubrizol Corporation. All rights reserved.

Confidential

BIO-BASED PUD FOR 2-COMPONENT NISO SYSTEMS

SUMMARY FEATURES & BENEFITS

- **Sustainability:**
  - Crosslinks with isocyanate free crosslinkers.
  - Formulates to <45/100 grams/liter EU/US VOC
  - 29% bio-based carbon content[1]
- **Efficiency:**
  - Enables high film thickness applications reducing number of systems layers
- **Performance:**
  - Excellent chemical and wear resistance.



29% Biobased Carbon Content (as a fraction of total organic carbon) Verified externally (ASTM D6866-18 Method B)
VOC measurements: Using European Union ISO 11890-2 / USA EPA method 24 /

© 2025 The Lubrizol Corporation. All rights reserved.

Confidential

Further questions?



© 2026 The Lubrizol Corporation. All rights reserved.

Lubrizol Confidential

THANKS!

PLEASE NOTE

BRAND NAME XPD, HPA OR TP INDICATE A PRODUCT IS STILL UNDER TEST MARKETING AND IS NOT YET COMMERCIALLY AVAILABLE. PLEASE ASK YOUR LUBRIZOL ACCOUNT MANAGER OR TECHNICAL CONTACT IN CASE OF DOUBTS REGARDING THE PRODUCT STATUS AND AVAILABILITY. TECHNICAL DATA IS PRELIMINARY. RECOMMENDATIONS AND SUGGESTIONS ARE MADE WITHOUT WARRANTY. OUR CONDITIONS OF SALES AND DELIVERY ARE VALID.

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

Confidential

Imagined for Life. Enabled by Science.™

lubrizol.com LinkedIn Instagram

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

Appendix

© 2025 The Lubrizol Corporation. All rights reserved.

New Product: bio-based functional PUD

Physical Characteristics:



Appearance (wet)	Water White Dispersion
Total Solids by Weight, %	45.0 ± 1.0
Total Solids by Volume, %	42.0 ± 1.0
Acid number (mg/KOH mg)	12.1
Density, lbs. /gal (g/ml)	1.0
Brookfield Viscosity, cps	< 100
pH	8.1
Freeze-Thaw Stability	Protect from freezing.

Property values represent typical results only and are not to be considered specifications

Lubrizol

© 2026 The Lubrizol Corporation. All rights reserved.

Confidential

Differentiated performance

Bio-based PUD(*) FORMULATION

COMPONENT A

Material	Pounds	Gallons	% Weight	Use
Blend in order with Agitation				
Bio Based PUD	813.42	92.96	93.69	Polymer
Premix the defoamer with water and add to above with agitation.				
D.I. Water	17.41	2.09	2.01	Water
Tego Foamex 822	0.09	0.01	0.01	Deformer
DPnB	37.30	4.93	4.30	Solvent
Total	868.22	100.00	100.00	

COMPONENT B

Material	Pounds	Gallons	% Weight	Use
Carbodilite E-07S	43.41		5.00	Crosslinker
Total Comp A + Comp B	911.63		105.00	

Physical Properties Formula Bio-bases PUD

Density, kg/l	1.04
Density, lbs/gal	8.68
Weight Solids, %	**42,5**
Volume Solids, %	39
EU VOC, g/L (ISO 11890-2)	45
US VOC, g/L (EPA Method 24)	95,42
US VOC, lbs/gal (EPA Method 24)	0.84

Lubrizol

© 2025 The Lubrizol Corporation. All rights reserved.

(*) October 2026: Formulation in optimization process. New tests and results will be provided as soon as available.

Lubrizol Confidential