Universidad de Castilla-La Mancha

DEPARTAMENTO DE INGENIERÍA QUÍMICA

CO_2-derived cyclic carbonates from fine ore a rotate-polyhydrocarbonates from isocyanate-polyurethanes (NIPUs) for coating sandal dressives

J.M. García-Vargas, P. Cruz Rodelgo, I. García, M.J. Ramos, M.T. García, J.F. Rodríguez

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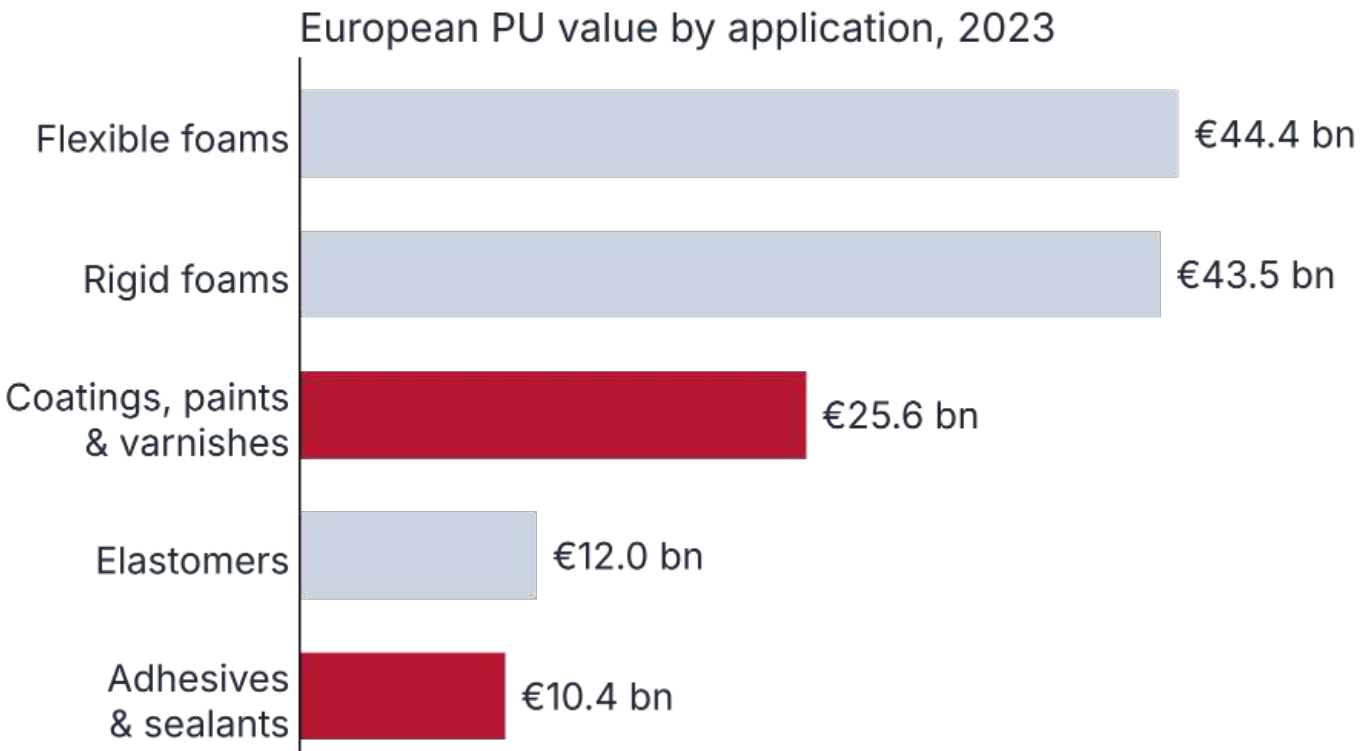
Future of Bio-Chemicals 2026 - Online - 12 November 2026

Polyurethanes: a huge market, coatings included



€233 bn
European value chain

7.2 million
jobs in Europe

$96 bn
global PU market, 2025

Sources: ISOPA/AIPA 2024 (2023 data); Future Business Insights

What is a polyurethane? Soft and hard segments

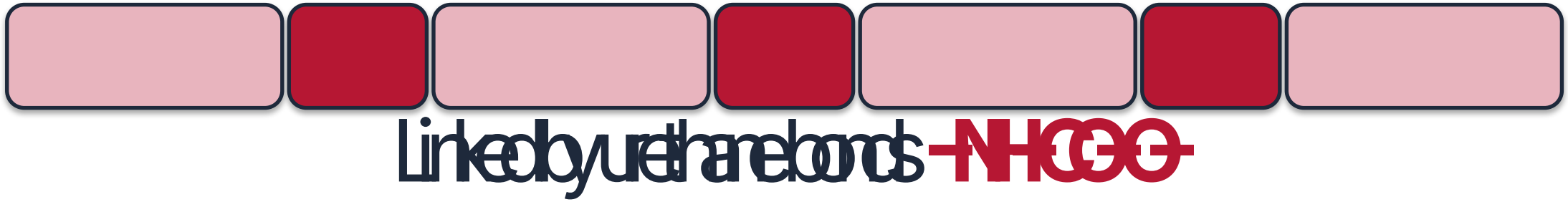
Long chain polyol

soft segment: flexibility

+

Disocyanate + chain extender

hard segment: strength



Technology used in research about isocyanates

- Made from amines + phosgene
- Respiratory sensitisers
- EU REACH: mandatory training since Aug 2023



CO_2 goes into the molecule, isocyanates stay out

Bio-based epoxide + CO_2 → Cyclic carbonate + diamine → Polyhydroxyurethane (NIPU)

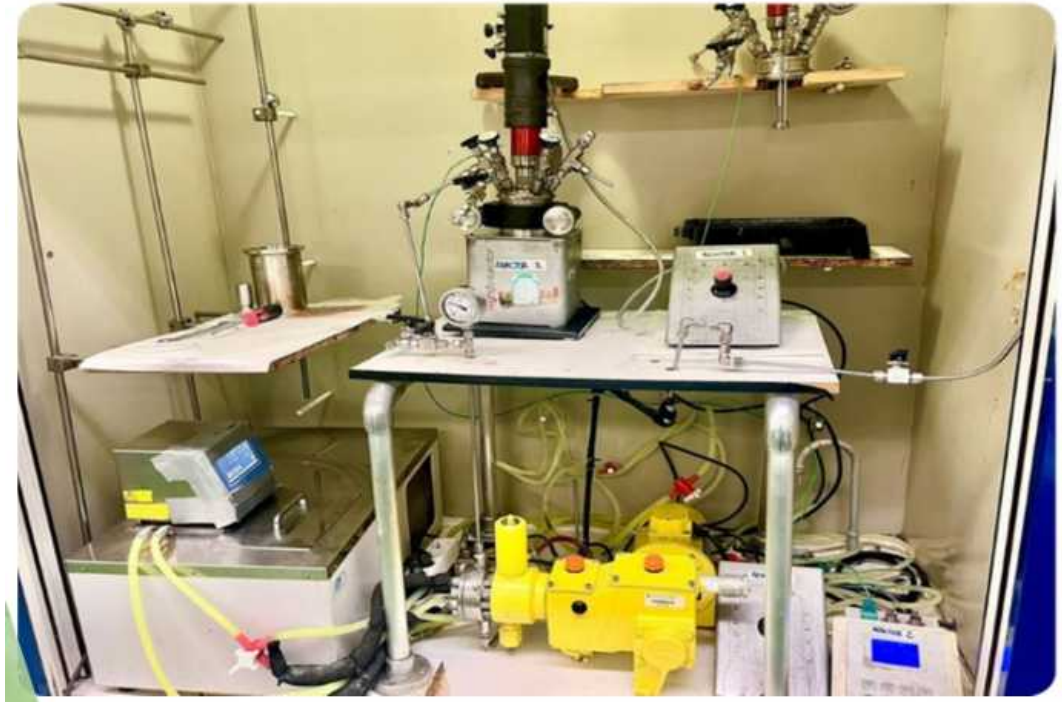


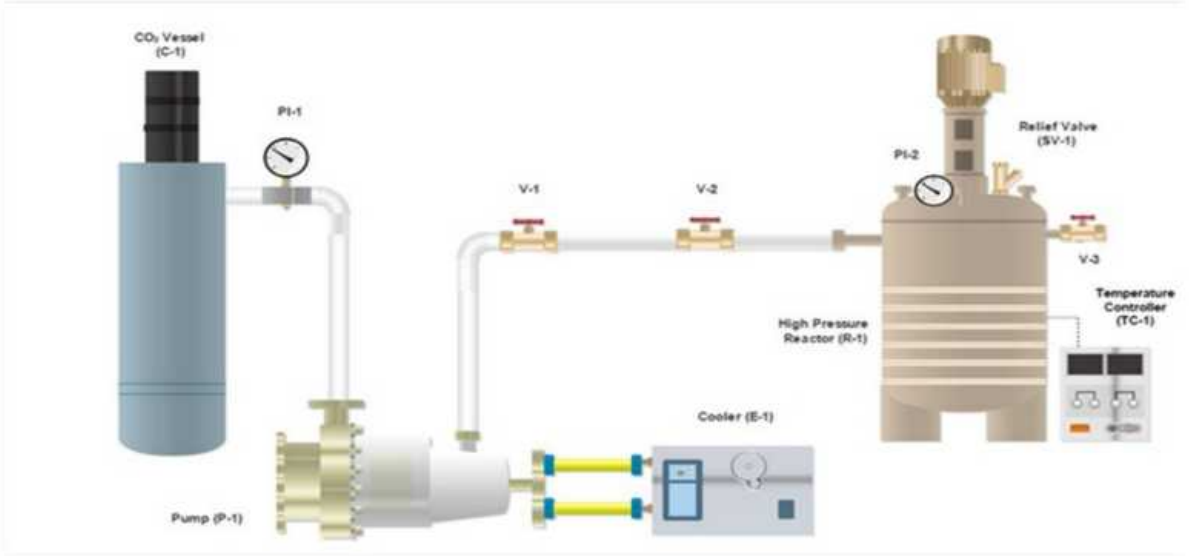
No isocyanates

No phosgene

Extra OH: better adhesion

Supercritical CO_2 reactor: absence of organic solvents





T_c = 31 °C · P_c = 74 bar · **No organic solvents**

Soybean oil: tunable, fully bio-based NIPUs

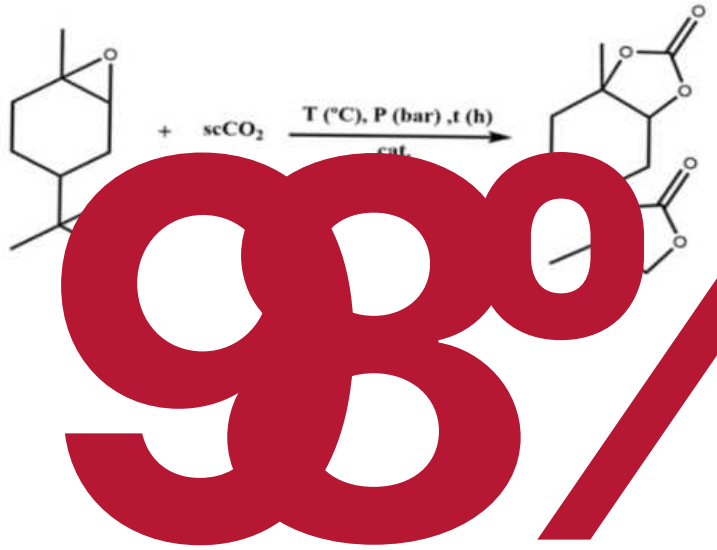
100%

bio-based NIPU

- Curing 90 °C, 6 h
- Tunable cross-linking density
- Stable up to 250 °C

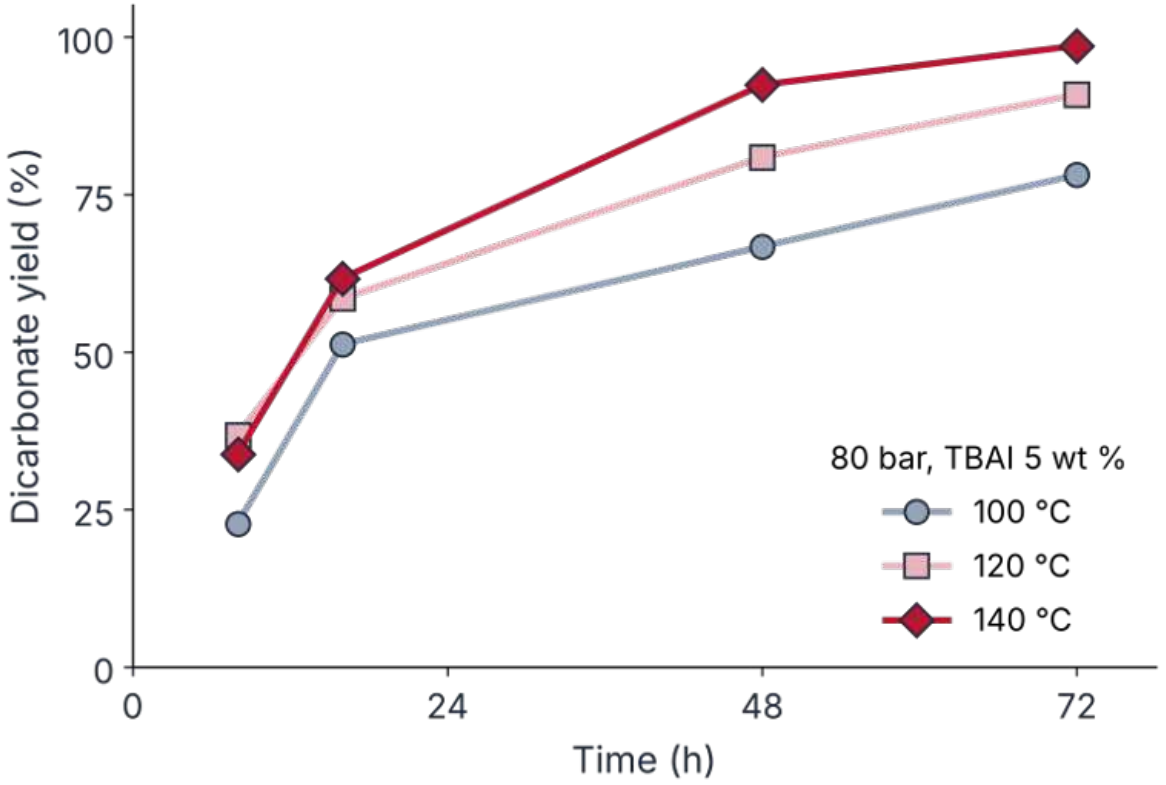
Cadiz et al., Polymers 2023, 15, 1589

Lignocellulosic-derived cyclic carbonate up to 98% yield

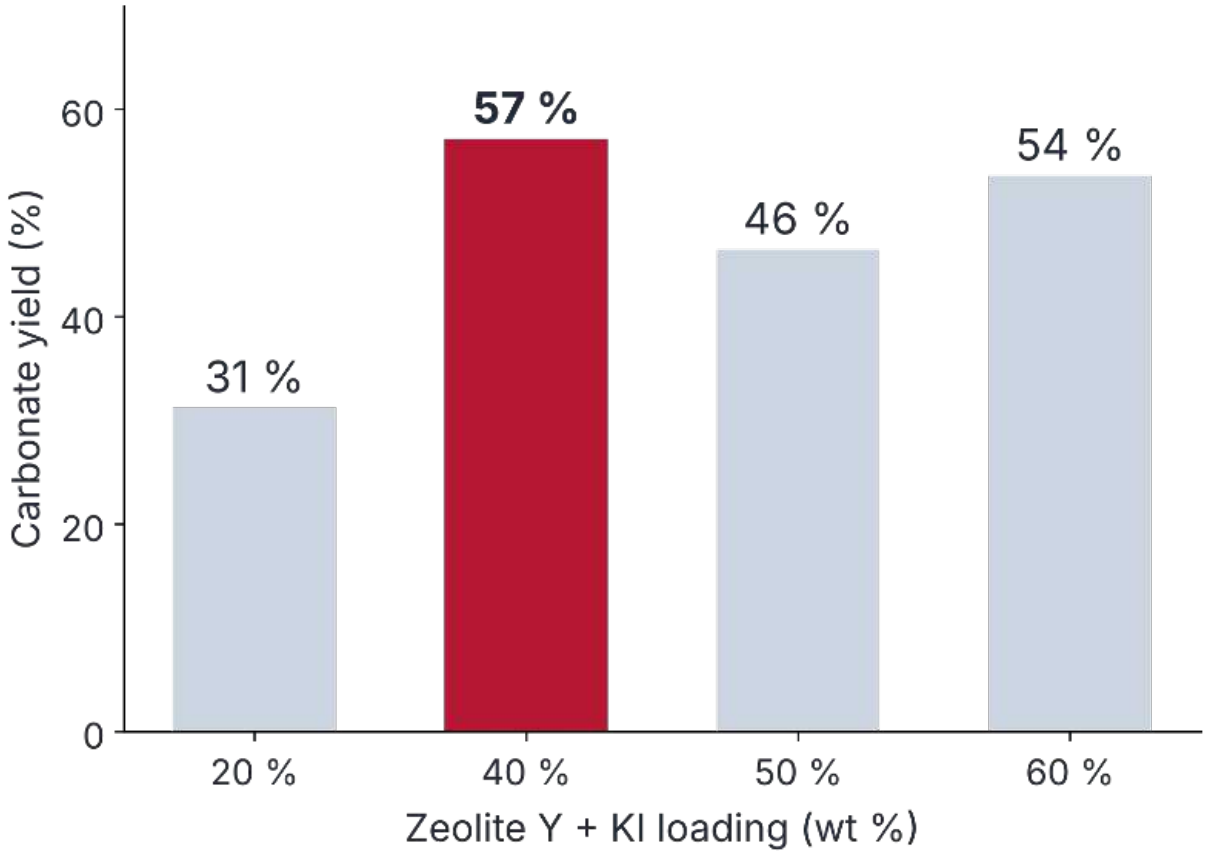


98%

80 bar · 140 °C · 72 h · TBAI



Acceptable zeolite catalyst: 57% in 24h



Zeolite Y+KI

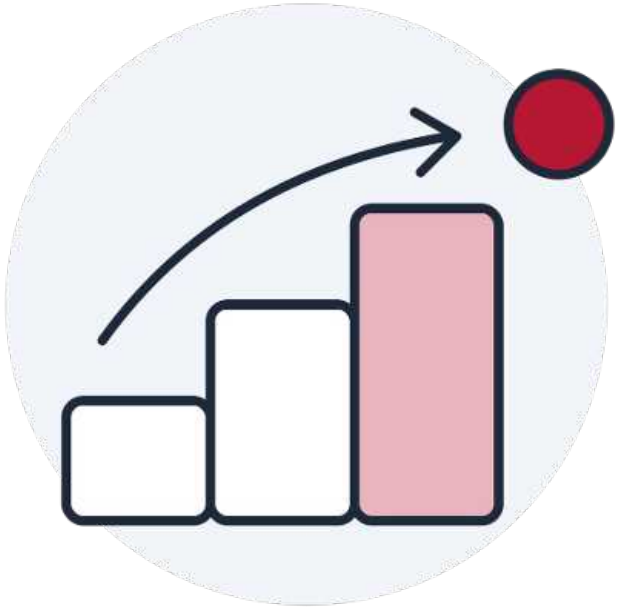
100 bar · 120°C · 24h

Filter cloth reuse

Wet NPUs offer coatings and adhesives formulators

- No discoyanates: no REACH training
- Moisture-tolerant curing
- OH groups: better adhesion
- Bio-based and CO_2-derived carbon

Next steps: faster, greener, fewer steps, tailored properties



1. More reactive catalysts
2. One-step from limonene + CO_2
3. Rigid terpene + flexible oil segments

Acknowledgements

BioNPUCO2

Isocyanate-free bio-polyurethanes via supercritical technology

SEPLY/23/180225/000130

Thank you!

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