CHEMICAL RECYCLING OF COMMERCIAL POLYURETHANE (PUR) FOR AUTOMOTIVE

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Bratislava 2025

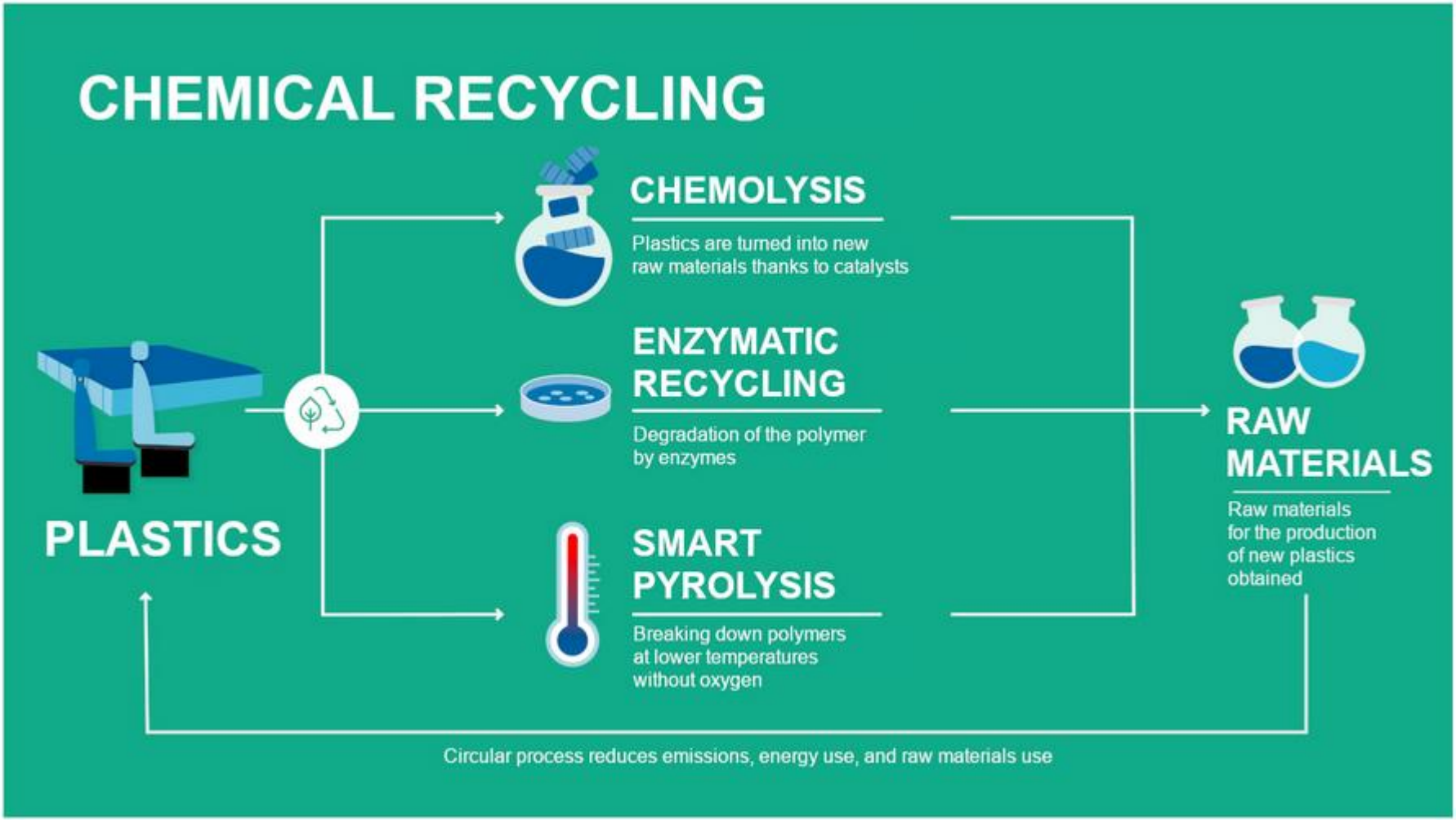
BASF company

- **B**adische **A**nilin & **S**oda **F**abrik
- Ludwigshafen, Germany
- In total **6 production segments**
  - Chemicals
  - **Materials**
  - Industrial Solutions
  - Surface Technologies
  - Nutrition & Care
  - Agricultural Solutions
- Revenue (2023) **68,9 bil. EUR**

We create chemistry

Chemical Recycling

- Material reusing in the same state
- **Chemical recycling of polymeric materials**
  1) Depolymerization
  2) Raw material
  3) Reusing of raw material in the initial product/manufacture
- Alternative to **Mechanical Recycling**


CHEMICAL RECYCLING
CHEMOLYSIS
Plastics are turned into new raw materials thanks to catalysts
ENZYMATIC RECYCLING
Degradation of the polymer by enzymes
SMART PYROLYSIS
Breaking down polymers at lower temperatures without oxygen
PLASTICS
RAW MATERIALS
Raw materials for the production of new plastics obtained
Circular process reduces emissions, energy use, and raw materials use

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PUR Chem. Recycling

- **PUR components**
  - Polyol
  - Isocyanate
- **Recycled Product** = **PUR** from **car headliners**
- **Goal** = recycling of the waste PUR foam in new headliners

PUR Chem. Recycling

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  - Polyol
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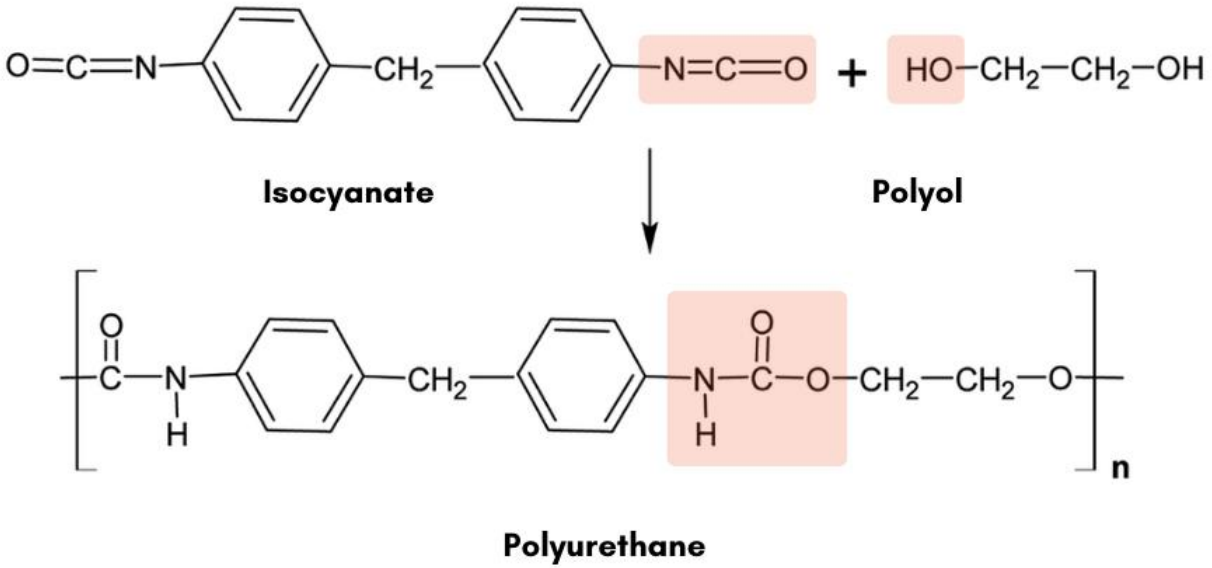
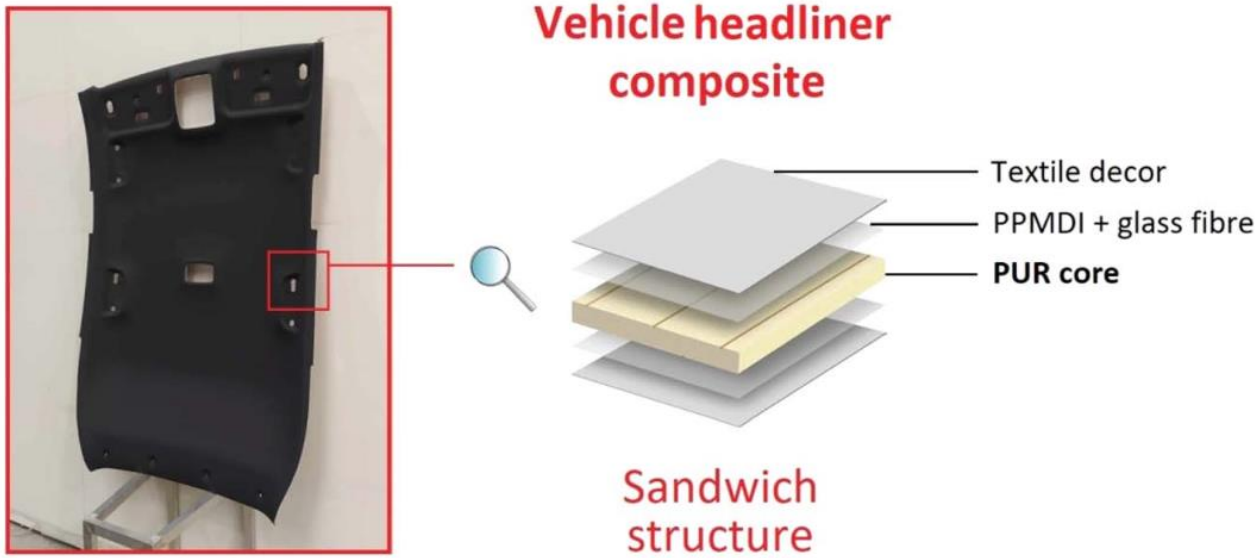


PUR Chem. Recycling



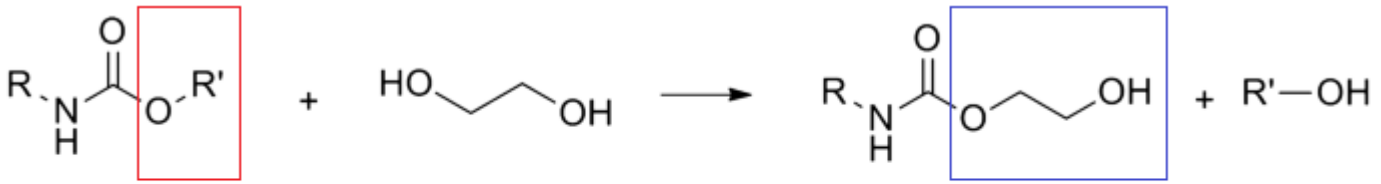
- **Recycled Product** = **PUR** from **car headliners**
- **Goal** = recycling of the waste PUR foam in new headliners

PUR Chem. Recycling

- Chosen pathway for the chemical recycling:

  Transesterification

  - **Polyol** in PUR substituted with another (typically glycerol/propylene glycol)
  - Polymer structure is transformed into a **low molecular liquid raw material**



Initial Polyol

Substituted Polyol (Ethylene glycol)

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Chemical Recycling with Castor Oil

RSC Advances

ROYAL SOCIETY OF CHEMISTRY

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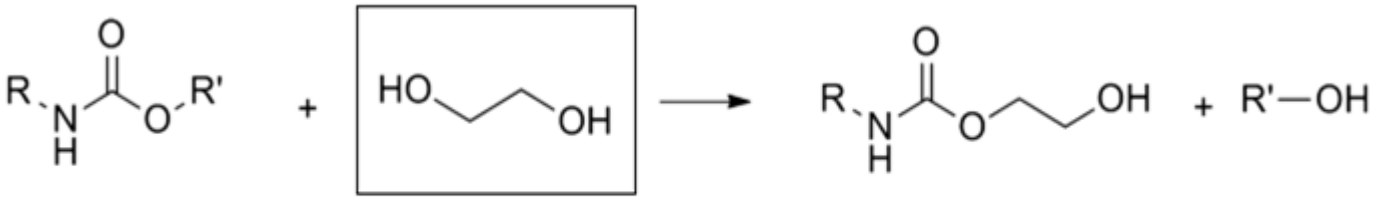
Cite this: *RSC Adv.*, 2024, **14**, 29966

Chemically recycled commercial polyurethane (PUR) foam using 2-hydroxypropyl ricinoleate as a glycolysis reactant for flexibility-enhanced automotive applications†

Vojtěch Jašek, *[a] Petr Montag,[bc] Přemysl Menčík,[a] Radek Přikryl,[a] Alena Kalendová[b] and Silvestr Figalla[a]

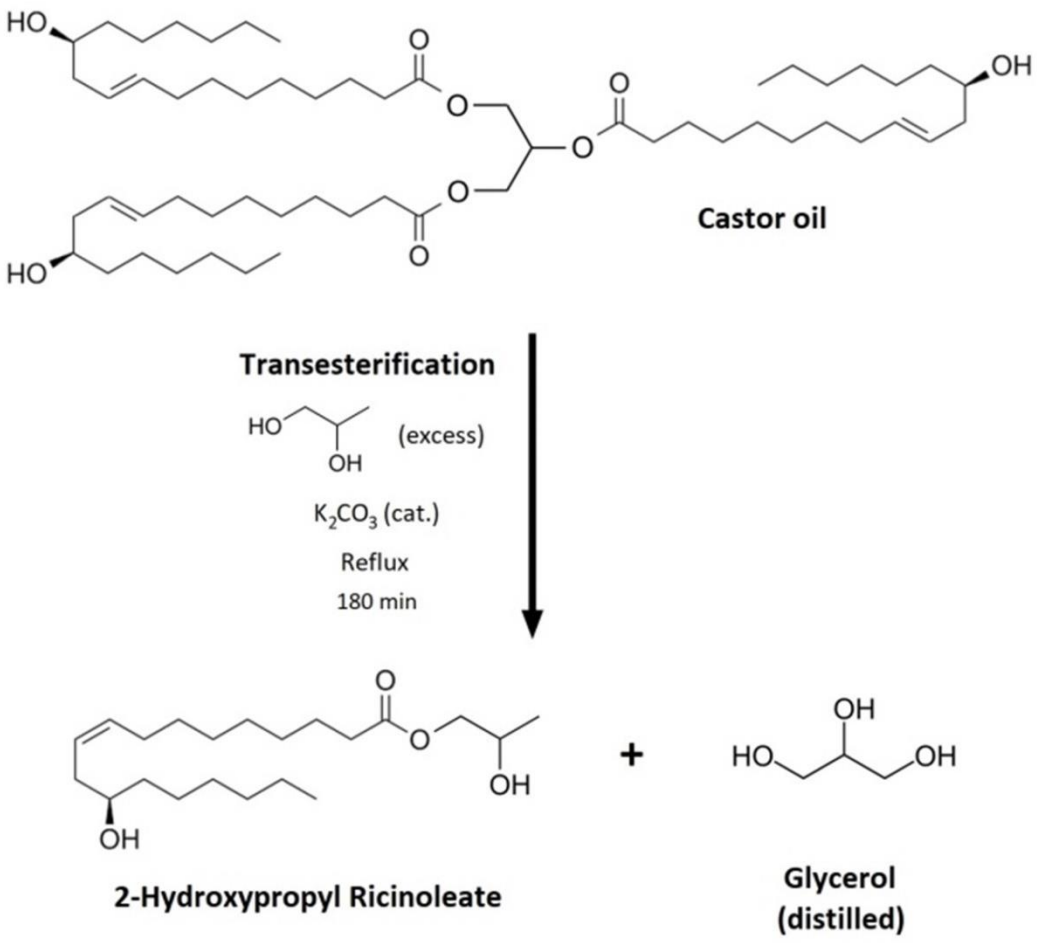
Chemical Recycling with Castor Oil

1) Synthesis of the **alternative polyol**
   - Compound **2-hydroxypropyl ricinoleate**
   - BASF requirement: **Elastic properties**
   - Appropriate are compounds with **long carbon chain** (chain extender)



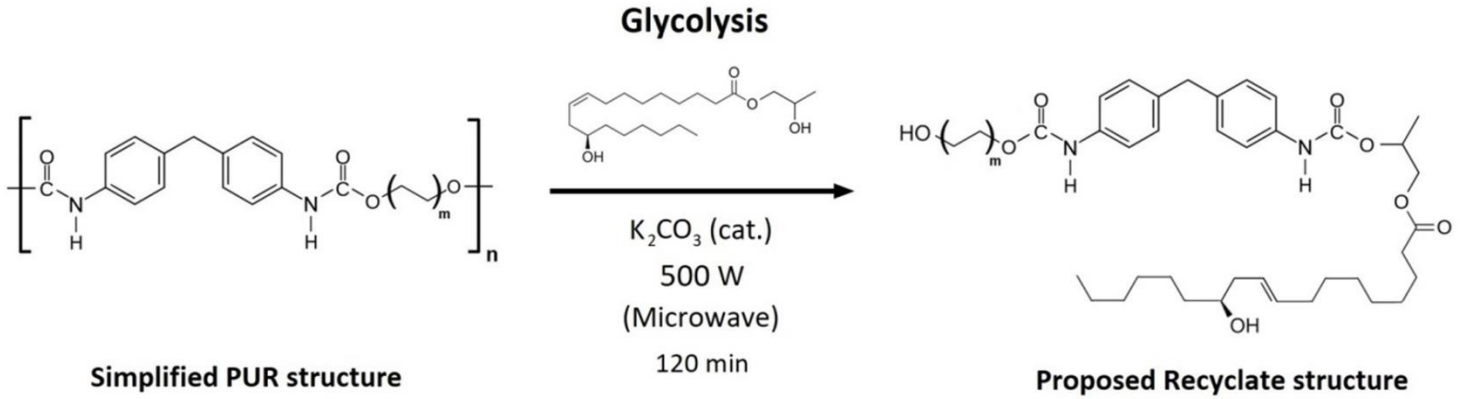
Target: Elasticity Increase

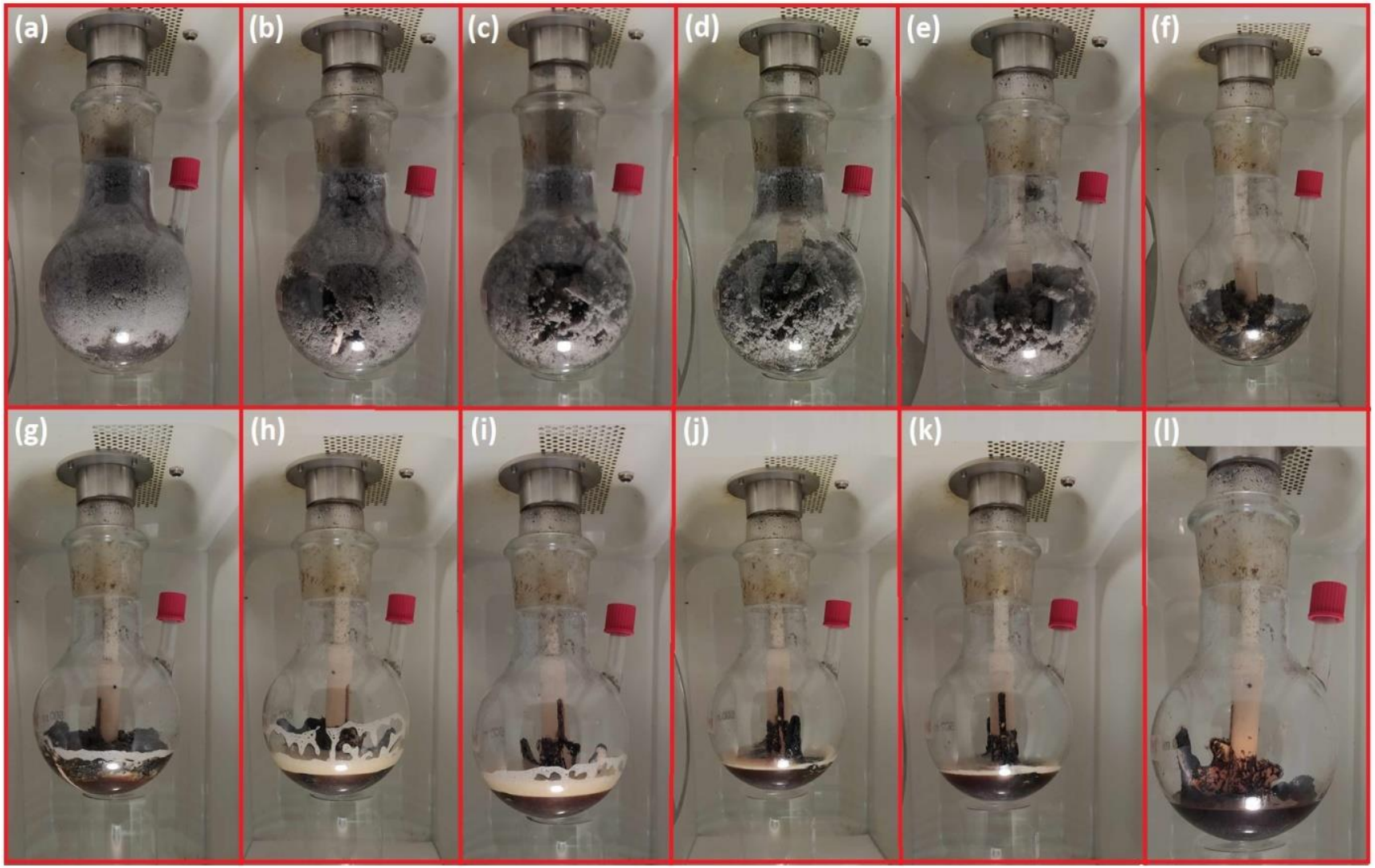
1) 2-HPR Synthesis



Chemical Recycling with Castor Oil

2) **Microwave-assisted** transesterification **depolymerization**
   - Foam transformation into liquid raw material
   - **Raw material analyzed**




(a)
(b)
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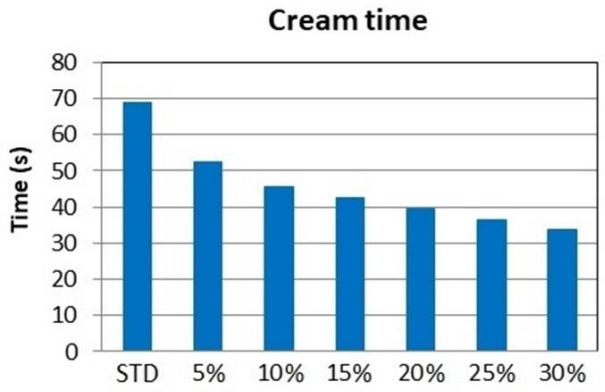
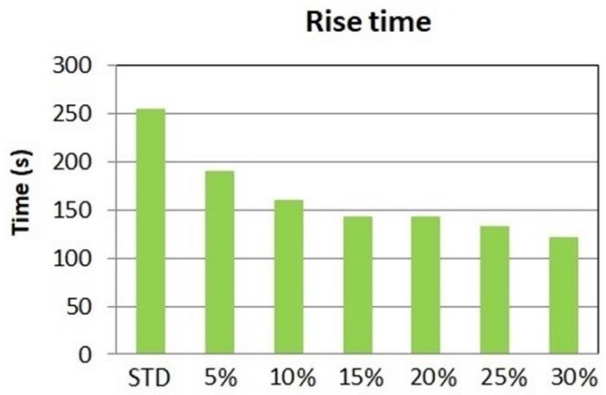
Chemical Recycling with Castor Oil

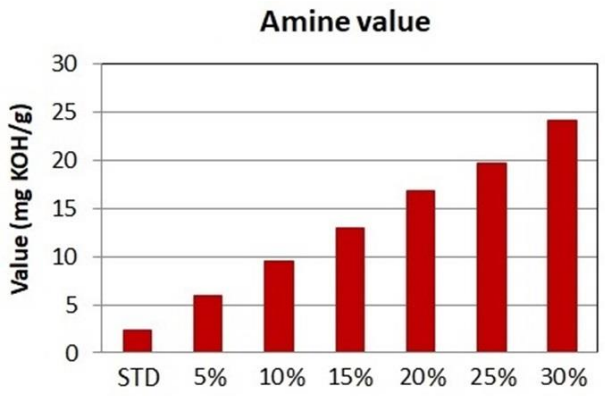
3) **Incorporation** of the **raw material** into foam
   - **Standardized cup-test** + other analyses
   - Reactivity increase
   - Foam density decrease

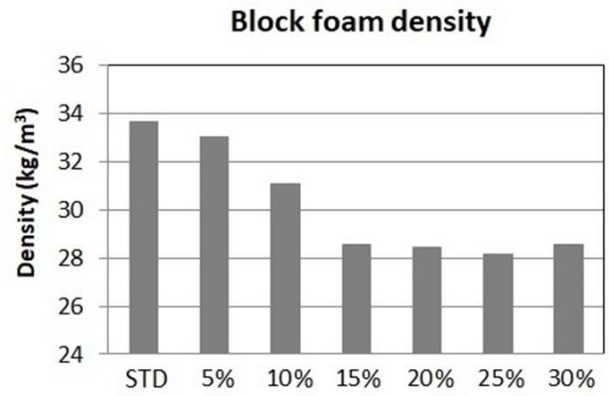
Chemical Recycling with Castor Oil

3) **Incorporation** of the **raw material** into foam









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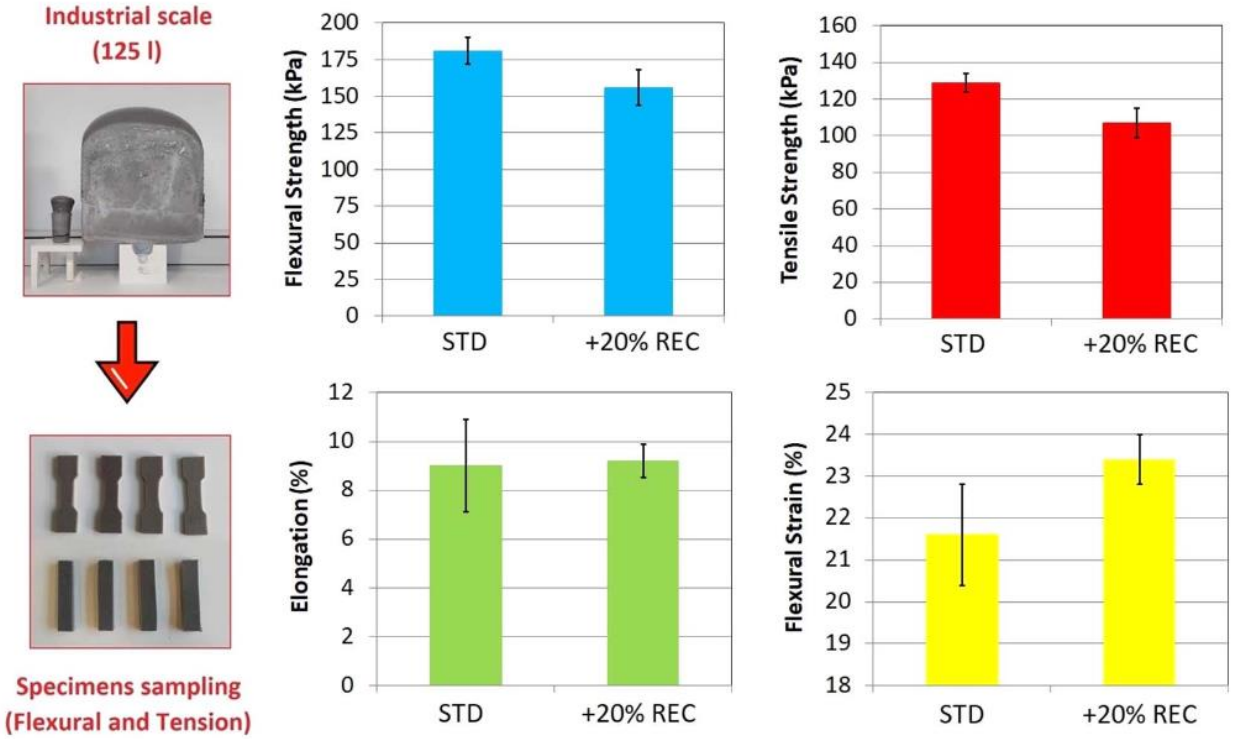
Chemical Recycling with Castor Oil

4) Comparison of the recycled and virgin foam

– **Elasticity increase** from tensile and flexural test



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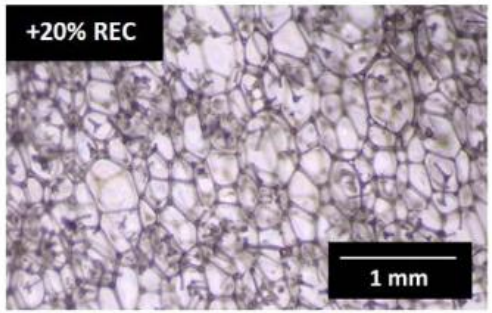
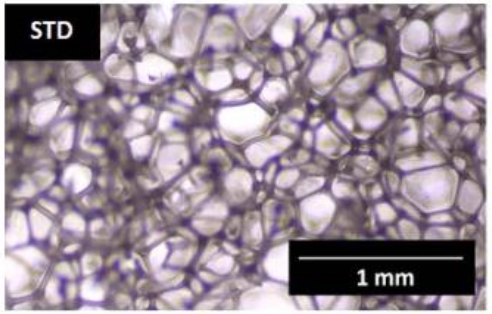
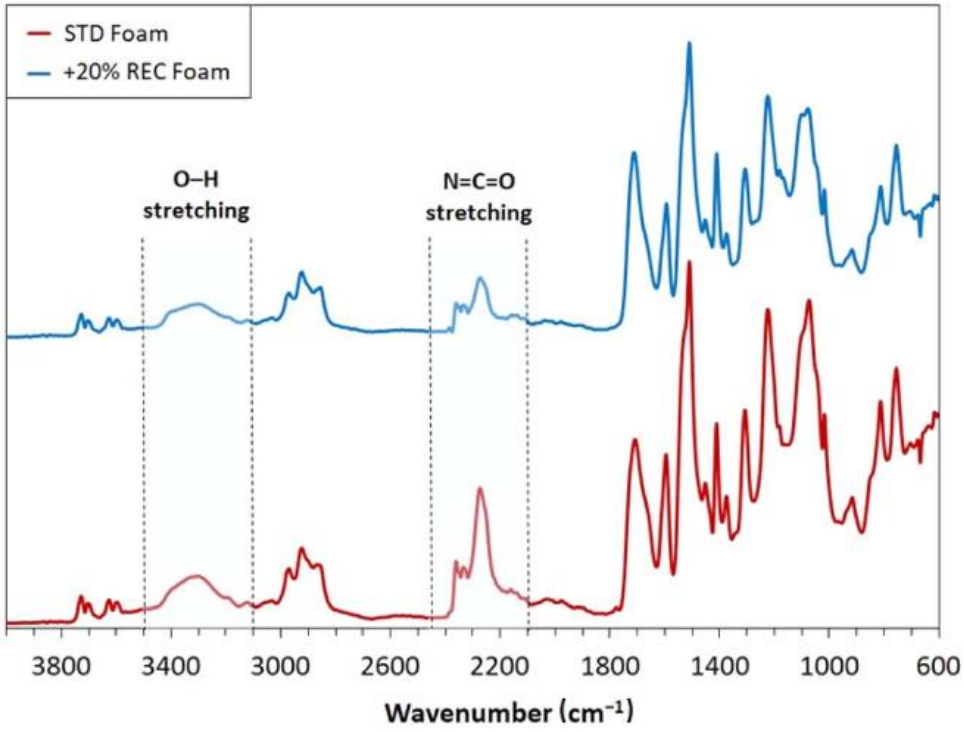
4) Comparison of the recycled and virgin foam

– **Porous structure** remained







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Summarization

- Successful synthesis of **2-hydroxypropyl ricinoleate**
- Quantitative **depolymerization** of the **commercial PUR**
- Optimal **recycled content** in the virgin foam polyol = **20 wt.%**
- The **elasticity increase** while structural properties were maintained