# Newsletter #01

MEET THE CIRCOPLAST PARTNERS

## Reinventing the circularity of polyurethane (PU) and polyisocyanurate (PIR) foams through a continuous reactive extrusion process

PU and PIR foams, whether flexible or rigid, are omnipresent in daily life. Their ease of shaping, light weight, durability, and weather resistance make them key materials for insulation, furniture, and decoration.

However, this widespread use comes with a **worrying increase in waste quantities**, which must be addressed to improve the circularity of these materials.

Every year, Europe generates **675 kt of PU waste**, **68%** of which is landfilled, while the industry produces **1.5 Mt** of flexible foam.

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Their thermoset nature greatly limits mechanical recycling options. Chemical recycling methods, such as solvolysis, offer real potential but require advanced technologies and significant investments.

**The need for innovative, efficient, and scalable industrial solutions is urgent.**

# CIRCOPLAST: a consortium committed to transforming PU/PIR waste

The CIRCOPLAST project aims to address these challenges. To do so, the consortium relies on an innovative, patented process developed by **Materia Nova**, the result of many years of research carried out within several projects, including the **FEDER UP-PLASTICS** project: **the chemical recycling of PU and PIR foams through reactive extrusion.**

This process takes place in several steps:

- **Grinding** of PU/PIR foams, whether flexible or rigid
- **Mixing** with a catalytic system and the required reactants
- **Processing** in a twin-screw extruder optimized for reactive extrusion

The initial work was carried out on a **Process 11 extruder (Thermo Scientific™, L/D = 40 and screw diameter = 11 mm)**, allowing optimization of reagent/catalyst ratios at a small scale (~100 g/h). A successful scale-up was then achieved on a **Leistritz ZSE 18 HPe (L/D = 50 and screw diameter = 18 mm)**, reaching a throughput of **1.5 kg/h**.

This process has been successfully tested on various types of foams (PU, PIR, rigid, flexible) originating from sectors such as automotive, insulation, and decoration. Remarkably, **complete depolymerization occurs in less than two minutes**.

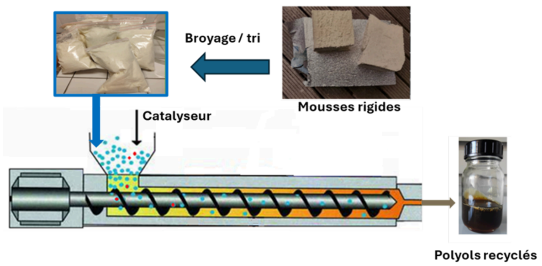


Figure 1: Diagram illustrating the innovative process patented by Materia Nova for the chemical recycling of polyurethane foams via reactive extrusion

**Characterization of the recycled polyols: a collective expertise effort**

Thanks to this process, solid PU/PIR foams were converted into a brown liquid in less than two minutes. This viscous liquid was then subjected to a series of in-depth analyses aimed at characterizing its structure and properties (viscosity, hydroxyl number, FTIR, NMR, X-ray fluorescence, chromatography, etc.).

The complementary expertise of the CIRCOPLAST consortium partners makes it possible to carry out all these analyses.

A key aspect of the study concerns **the identification of the flame-retardant system present in the original foam and the analysis of its behavior after treatment**. This step is essential to ensure the non-toxicity of the polyols and their components. Ongoing work aims to ensure that the recycling process not only valorizes the waste but also provides control over the composition and properties of the resulting materials.

# Towards new foams: highly promising industrial results

Preliminary tests conducted internally and with several industrial partners have yielded **very encouraging** results. The recycled polyols were successfully reintegrated into new foam formulations, blended with virgin polyols, with incorporation rates of up to **30%.** An example produced in collaboration with the company THIEME is shown in Figure 2.

# Moving Forward to Improve Circularity

Development efforts are progressing with the following goals:

- further optimizing recycling conditions and scaling up the process,
- valorizing the recycled polyols in new formulations,
- investigating blends with bio-based polyols, particularly those obtained from lignin degradation,
- incorporating bio-based flame retardants to improve the fire safety of the resulting foams.

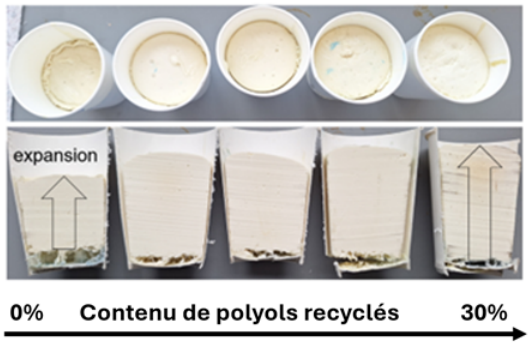


Figure 2: PU foams produced by the company THIEME, formulated from blends of virgin and recycled polyols obtained from the degradation of their foams using the process developed by Materia Nova. Reproduced with permission from THIEME.

These results demonstrate the compatibility of the process with existing production lines and highlight its potential to transform PU/PIR waste into high-value resources, benefiting sectors such as construction, automotive, and many others.

Avec le soutien de la Wallonie

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