PUReSmart
PolyUrethane Recycling Towards a Smart Circular Economy

Newsletter #3 – May 2022

PUReSmart progress: breakthrough steps

The PUReSmart project pursuing the ambition to develop new concepts to reshape the value chain into a closed loop. The consortium of 9 partners from 6 countries focuses on the development of a new PU chemistry with thermoset properties under its life conditions to be recycled when applying different conditions. The project, funded by European Horizon 2020 Research & Innovation Program entered his 4th year (running since 2019).

The project shows good progress and all partners are cooperative and contributing to the committed actions no longer being impacted by the global outbreak of Covid-19. In the first 3 years of the project, thanks to the fluent and professional cooperation between all partners, the progress is still considerable. This will move the whole project far beyond the state-of-the-art. This is also proven by the filed patent applications.

Wishing you all a pleasant reading! Bart Haelterman - R&D Director -

Smart sorting methodologies for PU foams

REDWAVE has built a **pilot machine for PU waste sorting**, containing all necessary units for sorting of flexible foam: an acceleration belt feeding the material to the machine, a detection unit comprised of halogen lights and a suitable spectral sensor, an ejection unit and two material shafts separated by a separation roll. The machine allows an easy and quick substitution of different components. Furthermore, extensive tests have been performed on comminution and screening equipment to define pre-processing steps for EoL flexible PU foams that consecutively allow highest throughput, yield and sorting quality.

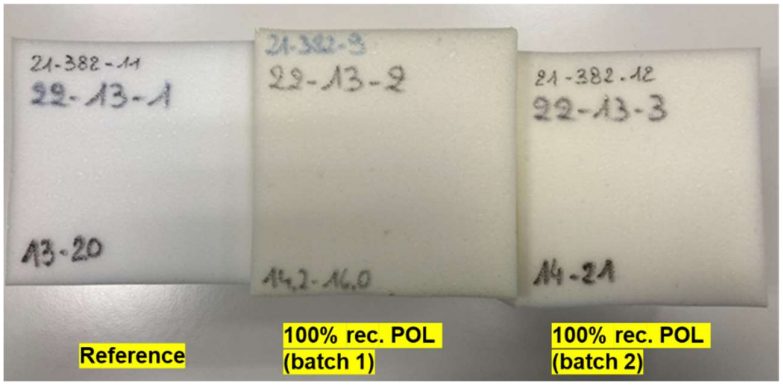
© REDWAVE

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 814543.
The PUReSmart project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

Smart chemolysis - improved chemolytic upgrading for PU containing EoL waste streams

A spreadsheet model estimating the PU recipe based on the different batches of recycled polyols was prepared, and gives a good idea which PU recipe can be used depending on the purity and properties of the recycled polyols.

Lab-scale flexible TDI based polyether PU foams were successfully produced with 100% recycled polyol with a minor change in the formulation. The chemolysis of a known conventional PU foam in the pilot-plant of Covestro produced the recycled polyol up to 99% purity and yield. The recycled polyol had similar properties like IOH, water content, viscosity when compared to a fossil fuel based conventional material. The recycled material was then used up to 100% in a standard conventional Recticel comfort foam formulation and the resulting foams had similar physical properties satisfying the comfort foam specifications when compared to the reference PU foam having 100% virgin polyol.



PU foams with 100% virgin polyol (reference) and 100% recycled polyol (batches 1 & 2)

RECTICEL ©
The passion for comfort

A procedure has been defined for **successful split phase chemolysis process** on > 5 kg foam scale, and provision of upper phase samples for pilot scale tests. The chemolysis at larger scale behaved similar to the smaller experiments at UCLM and KUL. The optimized multi-stage extraction process together with the subsequent solvent evaporation of the upper phase resulted in very high polyol quality.

Smart design - CAPU foam and its reprocessing

With the Smart Design objectives, it is the aim to introduce innovative chemical building blocks (CAPU comonomers) into polyurethane formulations that can substantially increase the intrinsic recyclability of these materials. The resulting portfolio of foam-compatibilized CAPU co-monomers via propoxylation allows the systematic investigation of PU foam materials in order to improve both their material properties, and to achieve an improved recyclability.

GHENT UNIVERSITY ©

Left picture: large scale synthesis of the newly designed CAPU comonomers - right picture: first batch of CAPU comonomers (>50 kg) now available for trials

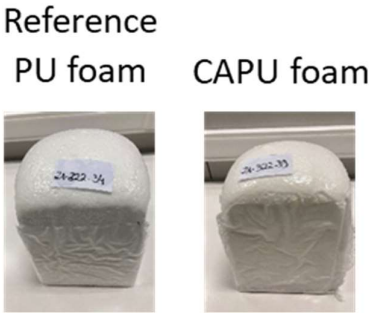
This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 814543.
The PUReSmart project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

A pilot scale synthesis of the urazole building block (>50 kg) for foam compatible TAD-based CAPU comonomers has been achieved. This synthesis demonstrates the industrial potential and accessibility of the novel technology, and will ensure that enough material is available to probe the technology's use for improving the recyclability of PU foam materials.

The scalability of a foam compatible CAPU comonomer is now foreseen without major issue.

PU foams containing CAPU comonomers and showing good physical properties were made on lab scale. The formulations however need further optimization as there seem to be a trade-off to be found between good physical properties and good recyclability.

© RECTICEL The passion for comfort



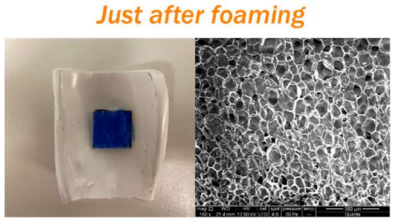
Reprocessing method for foam to elastomer and elastomer to elastomer

As an in-between step in the foam-to-foam reprocessing and to allow the evaluation and ranking of the new dynamic CAPU materials, the reprocessing of the obtained CAPU foams into elastomers has been evaluated. Those elastomers should then further be recyclable (elastomer-to-elastomer cycle) thanks to their covalent adaptable networks. The reprocessability of a CAPU foam into an elastomer is seen as a proof-of-concept of the recyclability of the material and is thus a prerequisite for the further foam-to-foam recycling development.

Refoaming of the CAPU in scCO2 results in a ≥15 times volume increase

© UCLM Universidad de Castilla-La Mancha

Piece of CAPU elastomer before (left blue) and after (left white + right) scCO2 foaming.



Density: 90 Kg/m3

Well-known for foaming of other thermoplastic materials, the scCO2 technique was first applied to thermoplastic PU elastomers in order to check the influence of the main experimental parameters. The effect of the CAPU crosslinking degree has been then studied by foaming different pristine CAPU elastomers and resulting in some good results in terms of the densities that are reached after foaming for the lower crosslinked CAPU samples.

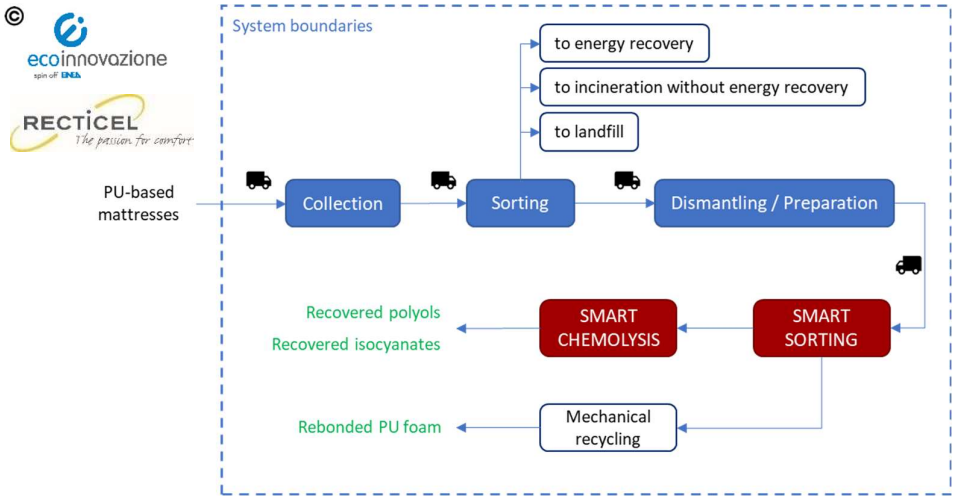
This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 814543.
The PUReSmart project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

Communication, Dissemination and Exploitation

Quantifying the environmental advantages and circularity of PUReSmart solution

The application of the Life Cycle Assessment methodology and the related calculation of the environmental footprint of the end-of-life management of polyurethane-based mattresses has been performed to fulfil three primary goals:

- Evaluation of the overall impact of state-of-the-art management systems and technologies for end-of-life mattresses in the EU, **with and without EPR** (Extended Producer Responsibility) systems in place and without PUReSmart solution.
- Quantification of the management of mattresses **with and without PUReSmart** (in 2030). These results will support the achievement of the project target of carbon footprint reduction.
- Comparison of the environmental **impacts of recovered materials** through PUReSmart recycling solutions vs virgin ones (i.e., polyols and isocyanates).



A sketch of the PUReSmart end-of-life management system (in red the innovative step developed, implemented, and tested within the project).

The preliminary results highlight the competitiveness of the environmental impact of PUReSmart solution, particularly regarding the recycling processes and recovered materials.

Quantifying the social innovation

A stakeholder workshop took place on the 8th of March, 2022, with 14 external participants, from value chain actors, associations, waste holders and treatment centres, and 15 participants from project partners.

The objective of the workshop was to define and evaluate social issues that might arise from the implementation of innovative technologies for PU recycling and their materiality. The workshop is part of a Social LCA we are conducting, on the PU and/or Mattrasses recycling value chain and takes into account international innovation in this field.

The goal of this research study is to assess the social benefits and impacts generated by the introduction of innovative chemical recycling technologies for mattresses at the end of life.

The elaboration of the received inputs is ongoing, and the outputs will be fed into the Social LCA framework, as defined by the UN Life Cycle Initiative Guidelines for Social LCA, integrated with insights gained during the project execution. The final results will be object of scientific publication.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 814543.
The PUReSmart project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

Scientific contributions are in preparation:

Call For Papers: Sustainable Chemistry and Pharmacy | ScienceDirect.com by Elsevier (https://www.sciencedirect.com/journal/sustainable-chemistry-and-pharmacy/about/call-for-papers#sustainable-by-design-approaches)

• Journal of Cleaner Production. Contribution about the environmental performances of chemical recycling of mattresses. (Ecoinnovazione + Recticel Covestro and Redwave)

The project will held a final workshop before the end of the year. This workshop will consist of a technical workshop of the consortium and a public dissemination part. More detailed information in the coming months!

Are you interested to contribute to the PUReSmart project or do you simply want to stay informed about all our news?

Please let us know by completing the following form
www.puresmart.eu/contact

CCs

- Recycling of end-of-life polyurethane mattresses by split-phase reactions - Link
- Sorting of plastic waste streams by near-infrared spectroscopy - Link

Follow us our website & Linkedin for further news...

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 814543.
The PUReSmart project results presented reflect only the author's view. The Commission is not responsible for any use that may be made of the information it contains.