

RAMPF – Groundbreaking Upcycling Approach for the Manufacture of Customized Polymer Aerogels

Unsorted polyurethane scraps as feedstock / Project funding by German Federal Ministry for Economic Affairs and Climate Action

Grafenberg, Germany, September 7, 2023. The RAMPF Group has developed a pioneering upcycling approach for the manufacture of customized polymer aerogels. In contrast to conventional methods that involve costly sorting processes, RAMPF's new technology enables the processing of mixed polyurethane-based production scraps into eco-friendly and ultralight materials for use in thermal insulation, lightweight fillers, rheology additives, and oil binding agents, amongst others.

The chemical recycling of plastics is increasingly becoming the focus of attention for its role in reducing the dependence on fossil fuels and mitigating the global plastic pollution crisis. It essentially involves breaking down plastic waste into its chemical components so that it can be reused as feedstock to produce new products instead of being landfilled or exploited in incineration plants.

Whilst conventional chemical recycling methods usually involve costly sorting and separating processes for different plastics into single-origin material flows or demand a high energy input, RAMPF has developed a groundbreaking chemical solution for the direct upcycling of unsorted polyurethane scraps into customized polymer aerogels.

This comprises the

1. Glycolysis of mixed polyurethane scraps to obtain a recycled polyol.
2. Synthesis of a polyurethane-based gel.
3. Supercritical drying of the wet gel to obtain an aerogel.

Dr. Gerd-Sebastian Beyerlein, Director of New Business Development at RAMPF and Technology Lead – “During the course of this development, we found that the technical properties of the aerogels are highly dependent on their physical microstructure, while the purity of the feedstock plays a less significant role. The aerogels we synthesized from different batches of mixed production scraps possess a well-defined and adjustable mesoporous microstructure as well as very low thermal conductivity in the range of comparable high-performance insulation materials. This demonstrates the robustness of this novel upcycling approach, which was developed completely in-house with regard to the materials used.”

Potential for upcycling diverse types of polymers

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For the development of a first proof of concept, mixed polyurethane production scraps from RAMPF Tooling Solutions RAKU[®] Tool modelling boards were used. However, preliminary tests indicate that the valorization approach is not limited to a certain type of polymer. This could open a path of cutting-edge research that will propose solutions for the treatment of complex plastic waste.

Dr. Beyerlein, who has been involved in the development of aerogel technology for over a decade, explains – “The transfer of this newly developed approach to other polymers as well as bio-based precursors could significantly accelerate the development of holistic circular economies. We are convinced that it has the potential to pave the way for a new generation of sustainable value-added polymers and can effectively contribute to the reduction of plastics waste in our ecosystem.”

The project has received funding from the German Federal Ministry for Economic Affairs and Climate Action and is part of the German cluster “Aerogels for Energy Efficiency” led by Prof. Dr.-Ing. Irina Smirnova, Head of the Institute of Thermal Separation Processes and Vice President Research of the Hamburg University of Technology – “This unique combination of aerogel and recycling technology is a very promising candidate for the industrialization of aerogels. Furthermore, the work being done by RAMPF demonstrates that implementing robust circular economy value chains can sometimes demand out-of-the-box thinking.”

Michael Rampf, CEO of the RAMPF Group – “With this new approach we have again demonstrated that we are a true chemical recycling pioneer. Whilst our company RAMPF Eco Solutions has been developing and optimizing the processing of sorted production scraps for more than two decades, we have now found a revolutionary solution that could signal the end of unsorted residues being incinerated or thrown in landfills.”

Detailed information on this technological development can be found in the recently published open-access manuscript “Novel robust upcycling approach for the manufacture of value-added polymers based on mixed (poly)urethane scraps”.

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The RAMPF Group stands for **engineering & chemical solutions** and caters to the economic and ecological needs of industry with six core competencies:

- > **RAMPF Machine Systems** based in Wangen (Göppingen), Germany, develops and produces multi-axis positioning and moving systems, trunk machines, and basic machines based on high-precision machine beds and machine bed components made from alternative materials such as mineral casting, ultra-high performance concrete, and hard stone.
- > **RAMPF Production Systems** based in Zimmern o. R., Germany, develops and produces production systems with integrated dispensing technology for bonding, sealing, foaming, and casting a wide variety of materials. The company also offers an encompassing range of automation solutions relating to all aspects of process engineering.
- > **RAMPF Composite Solutions** based in Burlington, Ontario, Canada, is a holistic composites supplier to companies in the aerospace, defense, transportation, medical, and green technology industries. The company offers a complete suite of services including composite part design and engineering, and metal-to-composite conversion engineering.
- > **RAMPF Eco Solutions** based in Pirmasens, Germany, develops chemical solutions for the manufacture of high-quality recycled polyols from polyurethane and PET waste materials. This company also designs and builds customized multi-functional plants for customers for the manufacture recycled polyols.
- > **RAMPF Polymer Solutions** based in Grafenberg, Germany, develops and produces reactive resin systems based on polyurethane, epoxy, and silicone. Its product portfolio includes liquid and thixotropic sealing systems, electro and engineering casting resins, edge and filter casting resins, and adhesives.
- > **RAMPF Tooling Solutions** based in Grafenberg, Germany, develops and produces board and liquid materials for cutting-edge modeling and mold engineering. The range of skills includes made-to-measure services and products such as pastes, large-volume and full-size castings for Close Contour models, and prototyping systems.

RAMPF has more than 850 employees and subsidiaries in Germany, the United States, Canada, Japan, China, and Korea.

All RAMPF companies are united under a holding company – RAMPF Holding GmbH & Co. KG – based in Grafenberg, Germany.

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