

RESEARCH NEWS

RESEARCH NEWSJune 2, 2025 || Page 1 | 3

Circular economy for packaging

AI: A Game Changer for Plastic Packaging

In the KIOptiPack innovation lab, researchers from the Fraunhofer Institute for Process Engineering and Packaging IVV are working with 51 partners from industry and the research sector to develop innovative AI-driven optimization tools and a data space that connects all of the stakeholders in the packaging industry and their data. The goal is to use AI tools to recycle plastic packaging in the future.

Plastics are lightweight, durable and easy to process, making them truly versatile materials for almost any application. This makes it no surprise that more than 60 percent of packaged goods in Germany are wrapped, bagged or boxed in plastic. The goal of the plastics industry is to support the circular economy through ideal packaging design (design for recycling), minimize environmental impact and at the same time provide optimum protection for packaged goods. Ideally, packaging will consist of as much recycled material as possible. New EU regulations also require plastic packaging to be made from up to 35 percent recycled material at a minimum by 2030.

Enter the research being done by KIOptiPack, one of two innovation labs that form part of the AI Application Hub on Plastic Packaging (see below, "The AI Application Hub on Plastic Packaging"), which is receiving funding from the German Federal Ministry of Research, Technology and Space. Together with their project partners, researchers at Fraunhofer IVV are using artificial intelligence as a game changer in recycling and for processing recycled material into packaging to meet the technological challenges and high standards involved in packaging production. The goal is to reduce plastic waste, create more sustainable packaging and lower demand for raw materials through reuse as recycled material, thereby increasing the reliability of the supply in Europe through a focus on circularity. To achieve this, the researchers at Fraunhofer IVV have developed AI-based optimization tools and connected them through a data space. This approach makes it possible to efficiently take account of the many requirements that plastic packaging has to meet. In particular, it also unlocks ways to recycle these packages and optimize them overall. Alongside environmental compatibility and impact, the aspects of functionality, design, customer acceptance and manufacturing feasibility are also factored in. After all the data is fully integrated, the AI tools suggest the best possible packaging designs for a certain product while also minimizing material use. The data space brings together all of the digital data on material properties, origins and destinations to do this and cross-links the information. In this way, it provides a shared infrastructure for exchanging data past the factory gates. The data model underlying the

Contact

Monika Landgraf | Fraunhofer-Gesellschaft, Munich, Germany | Communications | Phone +49 89 1205-1333 | presse@zv.fraunhofer.de
Karin Zacher | Fraunhofer Institute for Process Engineering and Packaging IVV | Phone +49 8161 491-359 | Gigenhauser Str. 35 | 85354 Freising | www.ivv.fraunhofer.de | karin.zacher@ivv.fraunhofer.de

full package, which enables the sharing of data among the various stakeholders in the first place, was also developed at Fraunhofer IVV.

RESEARCH NEWSJune 2, 2025 || Page 2 | 3

Digitalization of material flows to protect consumers

“To improve the incorporation of recycled materials into packaging solutions, a shared data space is crucial,” says Andrea Büttner, the institute director at Fraunhofer IVV.

“Recycled plastic is a valuable material. But the quality of the recyclable plastic has to be right. If the recycled material is contaminated with undesired substances such as other kinds of plastic, printing inks or degradation products, it can severely impair quality and even make the material unusable. Once plastics are recycled, they can contain contaminants in principle.” And that poses a particular challenge for the industry. This means that across the entire industry, from producers of recycled materials and companies that manufacture packaging films to the food sector, systematic data sharing is needed, along with a single language for dealing with plastics. The materials involved are mainly polyolefins, which represent the biggest group of plastics and can change substantially during processing.

AI helps with choosing the right recycling method

“AI-driven tools are a must when it comes to high-quality recycling of plastic materials. The modular software solutions we develop at Fraunhofer IVV help with aspects like characterizing and analyzing material properties, and they link different information flows together in such a way that a suitable field of application can be identified for recycled materials with fluctuating properties,” says Matthias Reinelt, head of the Shelf Life and Packaging Modeling group at Fraunhofer IVV. “Our AI tool for packaging production uses as much information as possible about the recycled material to determine the optimum processing chain so that what ends up on store shelves is a sustainably manufactured yogurt cup with homogeneous wall thickness and the desired shape, for example.” The researchers also analyze the quality of the recycled materials using chromatography, which in turn also relies on AI tools for improved substance identification. The goal here is to prevent unsuitable or contaminated recycled materials from entering the cycle, which can occur even with good sorting.

The AI-based optimization tools and interconnected data space provided by Fraunhofer IVV and its project partners are even directly incorporated into manufacturers’ production processes in some cases. This makes real-time suggestions for further processing possible, depending on the recycled materials being used on the machines on-site.

AI tools address recycled material gap

Use of recycled materials in plastic products is rising steadily. However, even despite this trend, the volume of recycled plastics will be insufficient to reach the levels of recycled materials required by law. This will lead to an ever-widening gap between supply and demand in the case of recycled plastics over the next few years. By 2030, demand

for recycled materials is projected to surpass supply by 30 percent. “Isolated solutions won’t be enough to bridge the recycling gap in the plastics sector in the long term. We are addressing this issue with our AI-driven optimization tools, which interlink material and information flows. We’re bringing the stakeholders from a wide variety of different industries together and trying to respond more effectively to resource shortages,” Büttner says.

Experts from the research sector, industry, government and associations from all across Germany will be gathering at the Zukunftsforum Kunststoffkreislauf event, to be held in Berlin from July 1 to 3, to discuss a full range of topics related to plastics, packaging and recycling of both. The goal is to bring people together to discuss innovative approaches to the transformation to a resource-efficient circular economy and translate concrete solutions into real-world practice.

More information is available here: <https://ki-hub-kunststoffverpackungen.de/veranstaltung/zukunftsforum-kunststoffkreislauf> (site in German).

The AI Application Hub on Plastic Packaging

To close the cycle for plastic packaging as much as possible, 51 partners from industry, the research sector and civil society are working together in two innovation labs: KIOptiPack, which focuses on design and production, and K3I-Cycling, which deals with recycling and sorting of materials. The labs were created to enable cross-lab sharing of data and ensure that all relevant findings are taken into account across the entire value chain.



Fig. 1 Experts at Fraunhofer IVV are optimizing a packaging production process. As part of the KIOptiPack project, they are also developing AI tools to make plastic packaging fit for the circular economy.

© Fraunhofer IVV