Fraunhofer ICT


# K 2022

**Messe Düsseldorf, Hall B7, Booth SC01/SC01-3**
**19th to 26th October 2022**

# Topics and exhibits

## Sustainable

**Isocyanate-free polyurethanes; exhibit 57**
Advantages in medical technology

**Performance upgrade for biopolymers; exhibit 59**
For use in demanding technical applications

**Hybrid and recyclable lightweight solutions; exhibit 60**
Component made of PLA and basalt fiber

**Sustainable sandwich structures; exhibit 70**
Made from monomaterial systems

**Lightweight pallet based on biofoams; exhibit 65a**
High quality, foamed, recyclable and stable

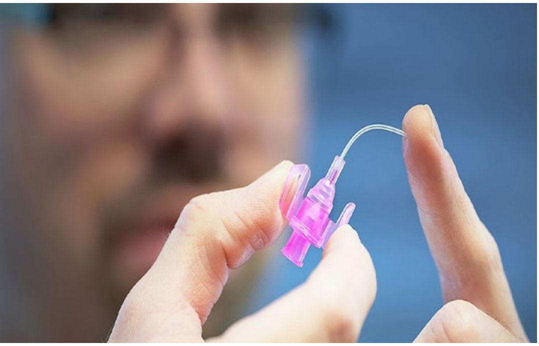
**Reactive extrusion with reduced $CO_2$ footprint; exhibit 58**
Environmentally friendly thermoplastic polyurethane elastomers (TPUs)

**Lighter electromobility; exhibit 69**
Direct-cooled electric motor - a further development

**Recyclable pultrusion profiles; exhibit 72**
Reactive thermoplastic pultrusion process

# Isocyanate-free polyurethanes

## Advantages in medical technology



*Tubing for medical technology is one of many applications for polyurethanes. Fraunhofer researchers are now producing this plastic sustainably without toxic isocyanates, on the basis of carbon dioxide ($CO_2$).*

**Conventional polyurethanes are made from toxic isocyanates and often show variations in material properties. Both these factors cause problems, especially in sensitive areas such as medical technology.**

Fraunhofer researchers have developed a production method for polyurethanes that dispenses with toxic isocyanates and at the same time uses carbon dioxide ($CO_2$) as a starting material.

The resulting materials meet requirements just as well as conventional polyurethanes and also have very reproducible material properties.

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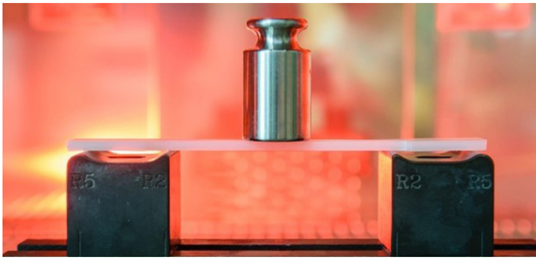
[Press releases 2021]

# Performance upgrade for biopolymers

## For use in demanding technical applications

Together with its project partners, Fraunhofer ICT is developing formulations for the production of customized biopolymer systems for processing by injection molding or melt spinning. In addition, foamable and extrudable formulations are developed for multiple applications, for example in the construction sector, the automotive industry or the textile industry. Where possible, the experts use combinations of self-reinforced biocomposites or biobased sandwich structures.




*Stereocomplex PLA formulations with high temperature resistance.*

*Seat shell consisting of self-reinforced biocomposites (PLA).*

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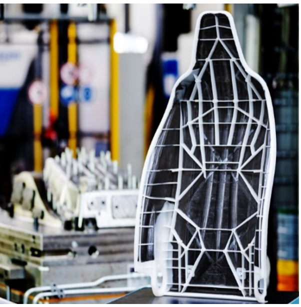
# Hybrid and recyclable lightweight solutions

## Resource efficiency through hybrid material composite systems

The hybrid material composite systems produced consist of a PLA matrix and basalt fibers. The underlying optimized and recyclable PLA formulation and the integrated basalt-fiber-reinforced UD tapes can be recovered (as basalt fibers and monomeric lactic acid) using an enzymatic recycling process. The composite properties of this sustainable lightweight structure are comparable to those of the polypropylene/basalt fiber reference system.



*Sustainable hybrid and recyclable seat back made of PLA and basalt fibers - optimized fiber-reinforced biopolymer system based on continuous-fiber-reinforced UD tapes and the adaptation of manufacturing processes (compounding and tape technology).*

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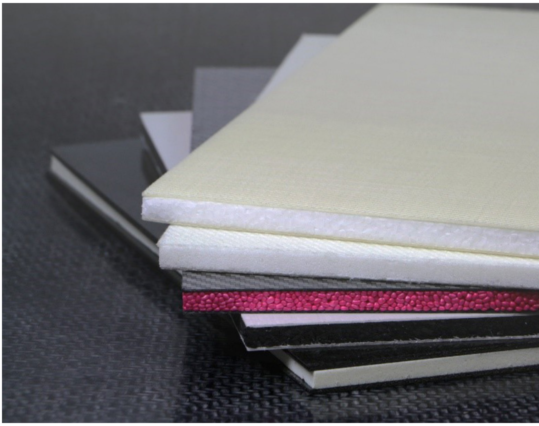
[Light Materials 4 Mobility]

# Sustainable sandwich structures

## Monomaterial systems are stable and can be recycled efficiently, giving them an ecological advantage

A promising approach to sustainable sandwich construction is monomaterial sandwich systems consisting of self-reinforced surface layers and foamed cores based on the same polymer. Demonstrators based on the polymers polypropylene, polyamide, polyethylene terephthalate and the bio-based polymer polylactide will be on display at the K 2022 trade show booth in Düsseldorf.



*High-volume sustainable sandwich structures.*

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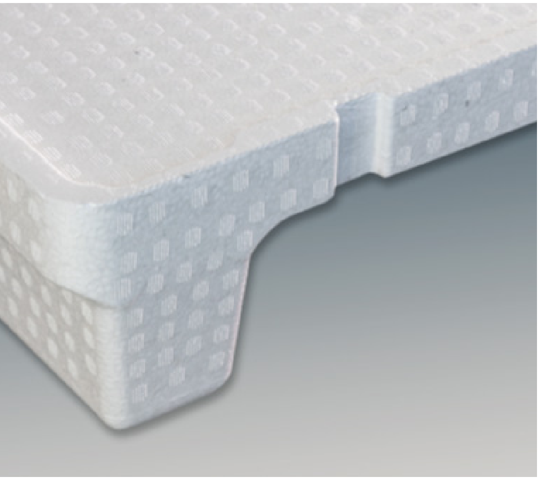
# Lightweight pallet based on biofoams

## The high-quality lightweight pallet made of foamed PLA particle foam reduces transport costs



*High-quality lightweight pallet based on foamed biopolymers.*

The "BioFLiP" project demonstrates how biobased polymers (PLA) and natural materials can be used in lightweight but high-quality applications. This lightweight pallet with modular elements and integrated functional components was specially developed for the transport sector. The lower weight and the selected materials of the pallet have a positive environmental balance. The pallet consists of a foamed core. The load-bearing capacity is achieved by surface refinement and reinforcing structures.

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Sustainability

# Reactive extrusion with reduced $CO_2$ footprint

## Production of thermoplastic polyurethane elastomers (TPUs)

The simple replacement of petroleum-based components with renewable alternatives in a well-established reactive extrusion process is a promising route to more environmentally friendly thermoplastic polyurethane elastomers (TPUs). However, it requires insight into the interactions between chemical reactions and material flow within an extruder, as well as a thorough understanding of the effects of heat and shear on polymerization and melt processing.

*Extruded strand from the continuous synthesis of thermoplastic polyurethane based on the new paraformaldehyde-based polyol: a renewable alternative to petroleum.*

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SIMPLIFY

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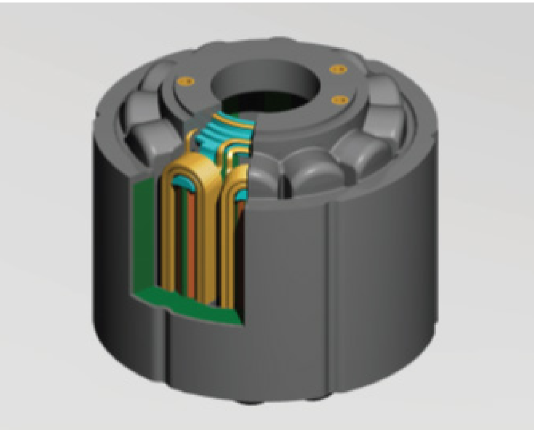
# Lightweight for electromobility

## Direct-cooled electric motor for traction applications using polymer materials



*Direct-cooled electric motor for traction applications; manufactured using polymer materials.*

No stone is left unturned in efforts to reduce the weight of electric vehicles and increase their driving efficiency. The focus is on optimizing the electric motor. In the manufacturing process, the pre-assembled stator with the assembled coils is overmolded with a thermally conductive, mineral-filled epoxy resin molding compound. This injection molding process creates the complex cooling channel geometry and encases the stator.

Using finite element simulations, the structure was designed to enable torque transmission through the overmolded stator and to ensure the sealing of the channels. Heat transfer simulations were used to analyze flow in the channels, estimate the cooling potential, and determine the pressure drop, which is within an acceptable range for automotive applications despite the narrow channels.

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# Recyclable pultrusion profiles

## More resource efficiency with thermoplastic continuous-fiber-reinforced plastics

**Alongside costs, the circular economy and resource efficiency are the key drivers for the competitiveness of new products. High-performance, continuous-fiber-reinforced plastics with a thermoplastic matrix made of polyamide 6 have significant potential to solve these challenges.**

A novel process for producing these high-performance composites is in-situ pultrusion with the monomer ε-caprolactam.

The low-viscosity monomer ε-caprolactam offers decisive advantages over comparable matrix systems. It polymerizes during processing to form polyamide 6. This continuous process thus enables high-performance profiles based on a recyclable thermoplastic material to be manufactured cost-effectively and with high productivity.

*Many years of experience in the field of pultrusion enable us to strike new paths. Concept and process developments in the reactive thermoplastic pultrusion process for the production of continuous-fiber-reinforced, thermoplastic profiles (e.g. e-caprolactam to polyamide 6).*

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# Topics and exhibits

## Functional

**Odor reduction and purification; exhibit 61b**
Emission and odor reduction in the compounding process

**“Wrapping up” odor-contaminated plastics; exhibit CCPE 61a**
Encasing skin to prevent odors

**Programmable materials with reversible functionality; exhibit 62**

**Acoustically optimized plastic housing; exhibit 71a**
Targeted optimization of sound emissions

# Odor reduction and purification

## Reduction of emissions and odors during compounding

*Plastics in car interiors sometimes release unpleasant odors and emissions. However, the release of these substances can already be significantly reduced during the compounding step through the use of extractive extrusion.*

Stricter legal safety requirements, the demand for higher quality products and the desire to use recycled polymers and natural-fiber reinforcement have led to an increased focus on the emission characteristics of polymer compounds, and an increased demand for emission- and odor-optimized materials.

All thermoplastic polymers suitable for processing in twin-screw extruders can be purified by this method. The main fields of application for this technology, which was developed at Fraunhofer ICT, are the removal of monomer residues from new materials, odor-intensive materials from specific formulations, and/or the removal of by-products from prior processing. Good results are also achieved with recycled materials.

Degradation products from (re-)processing or decomposition products of auxiliary materials (e.g. printing inks) and other odor-intensive impurities can be removed. Starting in the compounding step, unpleasant odors and emissions can be significantly reduced using extractive extrusion.

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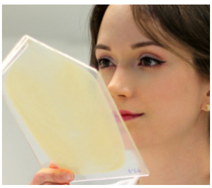
# “Wrapping up” odor-contaminated plastics

## Avoid odor release through the application of an encasing skin

**Plastic recyclates often have unpleasant odors. For many applications, for example indoors, these plastic recyclates cannot yet be used.**

To prevent odor release in the new application, the odor-contaminated plastic can be “wrapped up”. For example, sandwich injection molding can be used to produce components consisting of an odor-contaminated core material completely encased by a skin made of an odor-neutral material. As part of the circular plastics economy, the core and skin materials are made from the same class of plastics.

To achieve a permanent odor barrier, the odor-emitting chemical compounds must be prevented from migrating through the outer layer. In the Fraunhofer Cluster of Excellence “Circular Plastics Economy” CCPE, the four Fraunhofer institutes Fraunhofer ICT, Fraunhofer LBF, Fraunhofer IVV and Fraunhofer IAP jointly investigated odor barrier coatings for polymer compounds made from recycled materials. Using special additives, which are incorporated into the skin-forming plastic prior to component manufacture, this can be effectively achieved with a skin thicknesses of 0.25 mm.



**More info at:**
Press release

*Sensory evaluation of a sandwich test specimen with a recycled core and a skin material.*

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# Programmable materials

## Materials or material composites with a structure that enables specific properties to be controlled and reversibly changed

*Programmable materials can respond differently to a trigger in different locations, and have reversible functionality.*

Complex and locally diverging functions can be programmed. Depending on the application and the situation, the material then assumes different states and material properties initiated by external triggers.

Programmable materials open up potential for new system solutions because they take over essential system functionalities themselves, thus making additional system parts such as sensors or actuators superfluous.

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[Fraunhofer Cluster of Excellence]

# Acoustically optimized plastic housing

**Noise is a considerable burden in everyday life and in the workplace. Acoustically optimized products provide more safety, comfort and the "right sound"**

In the "PolymerAkustik" project, four Fraunhofer institutes have been working on the targeted optimization of sound emissions from plastic components.

Housings of small and large appliances were investigated in terms of the material and the manufacturing process. The result was a series of solutions - new characterization and simulation methods as well as new plastic materials and manufacturing methods for low-noise plastic housings.

*Too much sound can make you sick – this is scientifically proven. So why expose yourself to more noise than necessary?*

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# Topics and exhibits

## Recycling

**Optimized polylactic acid recycling; CCPE exhibit 67**
Energy-saving processing of post-consumer waste

**Waste mattresses – an ecological problem; CCPE exhibit 67**
Recycling as high-value polyurethane materials

# Optimized polylactic acid recycling

## Using a new energy-saving approach

*Optimized recycling of PLA using the example of post-consumer PLA waste from a public festival – energy-saving treatment involving alcoholysis for high quality recycling.*

**Processing of post-consumer polylactic acid waste using energy-saving alcoholysis for the recovery of ethyl lactate for high-quality recycling.**

PLA is initially produced by fermenting biomass such as sugar cane or corn to lactic acid, which is then polymerized to PLA. The two recycling processes established so far for PLA involve hydrolysis to lactic acid and thermal depolymerization to lactide, which can then be repolymerized to PLA. However, these conventional recycling processes are very energy intensive overall.

The new Fraunhofer recycling process "RePLACe", on the other hand, uses efficient alcoholysis to depolymerize PLA into alkyl lactate, which can be re-polymerized in an environmentally friendly process.

Here, the synthesis to ethyl lactate additionally leads to an upgrading of the recycled PLA waste. When all three processes are compared, it becomes clear that the new Fraunhofer process uses one third less energy on average.

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# Waste mattresses – an ecological problem

## Recycling as high-value polyurethane materials instead of incineration or landfilling

The process developed by the Fraunhofer Institute for Chemical Technology ICT in Pfinztal, near Karlsruhe, Germany, makes it possible to recover starting products for new, high-value PU materials from post-consumer mattresses. Starting from so-called secondary polyols, pillows, mattresses, insulation foams and adhesives are successfully redeveloped.

The application potential of secondary polyols produced by chemical recycling has been demonstrated on the basis of standardized tests. This will make it possible to significantly reduce the proportion of fossil-based polyols used in new syntheses in the future, while at the same time reducing the burden on landfills and incineration plants. However, the transition toward nationwide recycling plants will still take many years.

*In Europe alone, around 30 million mattresses must be disposed of each year. About 40 percent are incinerated, and 60 percent are landfilled. Recycling is possible and worthwhile. In the URBANREC project, Fraunhofer ICT has developed a processing method.*

*PU foam made of secondary polyol.*

**More info at:**
Press release

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