Thermoforming natural fibre thermoplastics: Recyclable semi-finished products

About this project

NatureCase

Thermoforming natural fibre thermoplastics: Recyclable semi-finished products

Markets:

Material: Natural fibres, Thermoplastics, Woven fabrics, Nonwovens, mats, Others (Carbon fibre nonwoven PP semi-finished products), Natural fibre reinforced plastics (NFRP)

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This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

Context

In sectors such as the automotive and construction industries, lightweight components made from fibre-reinforced plastics help to reduce weight and thus lower energy requirements during use. At the same time, the energy-intensive production of many fibre materials has an impact on the carbon footprint even before the component is manufactured. For widespread use, materials are therefore needed that combine an improved environmental footprint with processing in established, automatable forming processes.

One approach is organic sheets: flat, consolidated thermoplastic fibre composite semi-finished products that can be formed in a heated state. In practice, however, many of these semi-finished products can only be deep-drawn to a limited extent. With high degrees of forming and complex geometries, folds, cracks or gaps occur in the fibre structure. This reduces component quality and increases rejects.

Natural fibres can support the forming process because they are present as staple fibres and can shift against each other in the textile composite. Until now, however, natural fibres have often been combined with thermoset matrix systems. These cannot be remelted, make recycling more difficult and are only suitable for thermal forming processes such as deep drawing to a limited extent. This means that there is no recyclable natural fibre thermoplastic semi-finished product that can be reliably formed into thin-walled, complex components.

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Purpose

The project team is developing a thin-walled, natural fibre-reinforced thermoplastic semi-finished product that enables automated thermoforming processes for complex geometries. To this end, the participants are designing the fibre, matrix and layer structure in such a way that the material remains sufficiently flowable in the process, is dimensionally stable and achieves a strong fibre-matrix bond.

The researchers are trialling the deep-drawing process experimentally and verifying the mechanical properties of the components through tests. The project partners are also developing a protective layer that reduces moisture absorption and can be moulded together with the semi-finished product. Another focus is on recyclability: the project team returns production waste and damaged components to the semi-finished product production process and compares components made from recycled material with new parts.

As a demonstrator, the participants are producing a suitcase shell, as it represents high degrees of deformation and typical draping problems. Finally, the project team assesses the ecological impact using a life cycle analysis and compares the results with established materials.

Procedure

First, the participants define requirements for natural fibres and thermoplastic matrices, characterise suitable combinations and classify the results in material overviews. Building on this, they develop pre-treatments that specifically improve the temperature resistance, adhesion and moisture behaviour of the natural fibres.

The project team then produces layered semi-finished products and investigates their behaviour in the thermoforming process. In addition, it maps material combinations in digital models, checks the predictions in forming tests and gradually adapts the material and process control.

The participants then test the components mechanically and analyse the protective effect of the coating against moisture absorption. At the same time, the project team returns rejects and destroyed components to the process, produces new semi-finished products from them and compares the component characteristics. Finally, the project team assesses the environmental impact and derives steps for the transfer to industrial process chains.

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Funding duration:

Funding sign: 03LB2071 **Funding amount:** EUR 835 thousand

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB2071A - NatureCase in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products Semi-finished parts, Others (Travel cases in various designs (aluminium, plastic or FVW))	✓
Services & consulting Training, Testing and trials, Prototyping	✓

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Lightweighting classification

	Realisation
Field of technology	
Design & layout Hybrid structures	✓
Functional integration Others (Water-repellent coating)	✓
Measuring and testing technology Others (Optical inspection)	✓
Modelling and simulation	
Plant construction & automation	
Recycling technologies Recycling	✓
Manufacturing process	
Additive manufacturing	
Coating (surface engineering) Plasma process	✓
Fibre composite technology Pre-preg processing, Others (Thermoformed thermoplastic composites based on hybrid tape fabrics)	✓
Forming Thermal converting, Deep-drawing	✓
Joining	
Material property alteration	
Primary forming	
Processing and separating	
Textile technology Fibre manufacturing, Braiding, Yarn & roving production, Preforming, Textile surface treatment and finishing, Nonwoven & mats production, Weaving, Knitting, laid web production, Others (Tape fabric)	✓

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Natural fibre reinforced plastics (NFRP)	✓
Fibres Natural fibres	✓
Functional materials	
Metals	
Plastics Thermoplastics	✓
Structural ceramics	
(Technical) textiles Woven fabrics, Nonwovens, mats, Others (Carbon fibre nonwoven PP semi-finished products)	✓