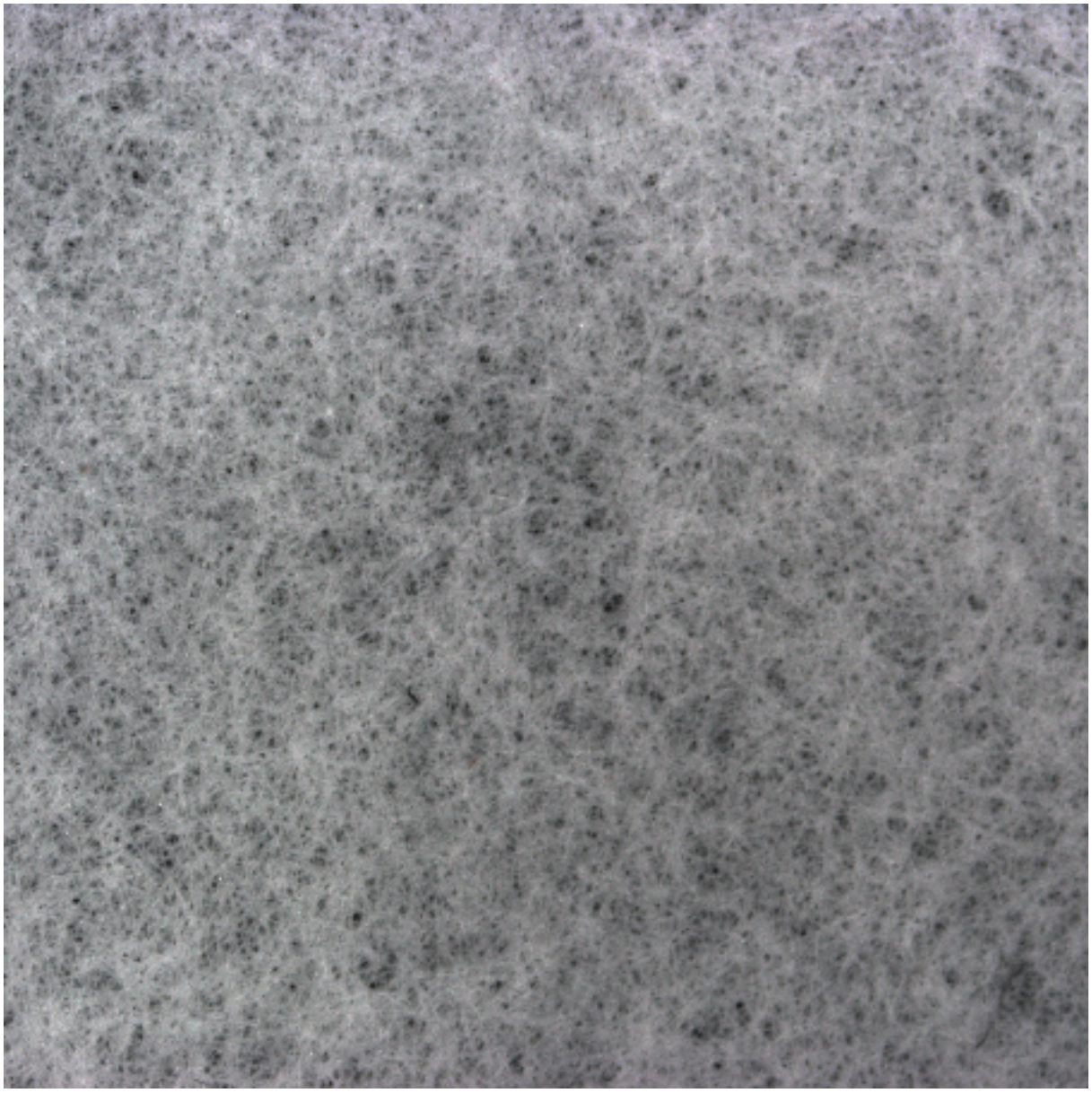
Paper and cardboard for sustainable lightweight construction: digital tools capture fibre networks

About this project



DiPl-HFC

Paper and cardboard for sustainable lightweight construction: digital tools capture fibre networks

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About this project

Markets: 

Material: Wood, Natural fibres, Laminates

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

Paper and cardboard offer great potential for sustainable lightweight construction. They are made from renewable raw materials, are light, stable, easy to mould and recyclable. The paper and cardboard processing industry in Germany - a predominantly medium-sized sector with around 84,000 employees - already uses these materials on a large scale, for example in packaging, technical moulded parts or functional layer composites.

However, in demanding applications - for example in automotive interiors, in furniture components or as laminating components in the construction industry - conventional design methods reach their limits. The mechanical behaviour of the materials is complex, and up to now there has been a lack of reliable digital models for design and process control. In order to be able to use the materials in a more targeted and efficient manner, sound data, simulation-based tools and an end-to-end digitalised process chain are required. This is where the DiPl-HFC team comes in: It combines modern measurement and simulation techniques with the aim of systematically developing fibre-based materials further.

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Purpose

The researchers in the DiPl-HFC project want to utilise the lightweight construction potential of paper and cardboard in a targeted manner. They are developing digital tools that can be used to precisely investigate fibre networks and realistically simulate material behaviour. They are paying particular attention to inhomogeneous structures such as fibre orientations or density distributions, which have a significant influence on forming properties. Such effects can already be modelled for established lightweight construction materials - this has hardly been possible to date for fibre-based materials such as paper.

The project team is also integrating recyclability criteria directly into the digital design. In this way, the researchers are creating a basis with which companies can use fibre-based materials made from renewable raw materials more efficiently and reliably - and thus meet the requirements for sustainability, product quality and resource conservation at the same time.

Procedure

The researchers first analyse the microstructure of paper and cardboard using an imaging measurement method. In doing so, they record fibre density, orientation and local defects. On this basis, they create digital twins and develop multi-scale simulation models that map the material behaviour from the fibre structure to the component level. This allows them to realistically predict mouldability, strength and failure risks - even in the case of typical material scattering.

At the same time, the project partners are digitalising the entire process chain. They are developing a platform that links design, forming and material behaviour. Recycling aspects, such as fibre quality or recyclability, are also incorporated into the models.
The team is trialling all methods under real production conditions. The results should not only benefit the packaging industry, but also be transferable to lightweight construction applications in the automotive, furniture and construction industries. A dimensioning concept and a guideline ensure practical use and broad applicability.

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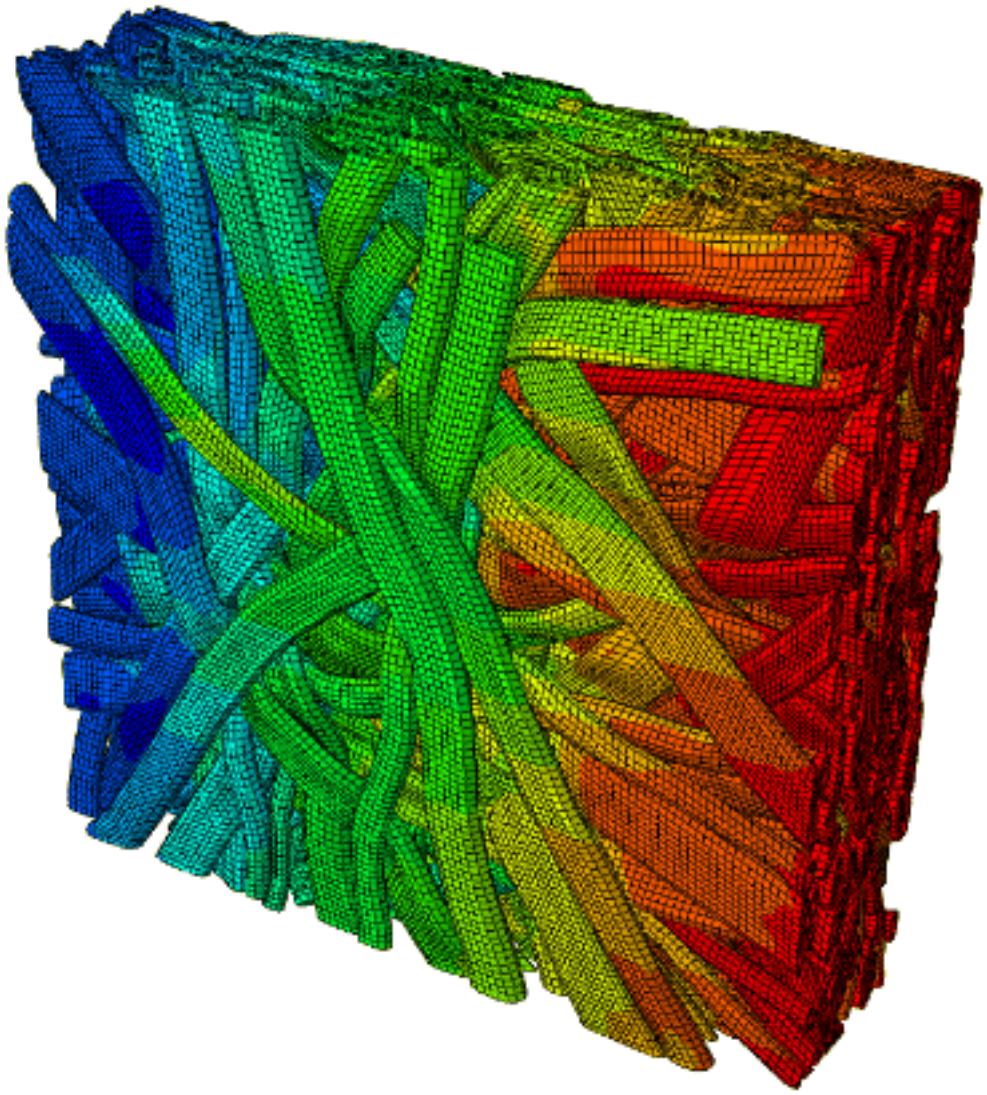

Funding duration:

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Final report

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Project coordination

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English (EN){{ Projektpartner }}

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Software & databases, Tools and moulds	✓
Services & consulting Engineering, Validation, Simulation	✓
Field of technology	
Design & layout Lightweight design	✓
Functional integration	
Measuring and testing technology Materials analysis	✓
Modelling and simulation Loads & stress, Optimisation, Structural mechanics, Materials	✓
Plant construction & automation	
Recycling technologies Recycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming Deep-drawing, Others (Creasing, folding, draping)	✓
Joining Adhesive bonding	✓
Material property alteration	
Primary forming	
Processing and separating	
Textile technology	
Material	
Biogenic materials Wood	✓
Cellular materials (foam materials)	
Composites Laminates	✓
Fibres Natural fibres	✓
Functional materials	
Metals	
Plastics	
Structural ceramics	
(Technical) textiles	