Fraunhofer

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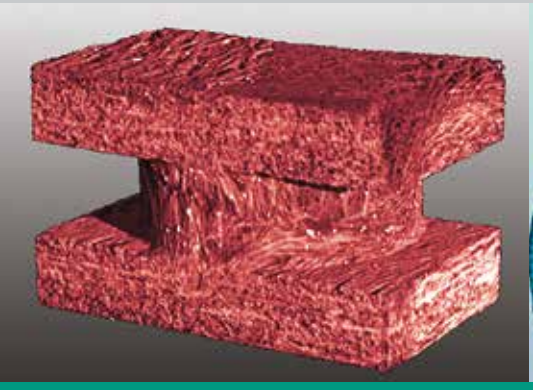
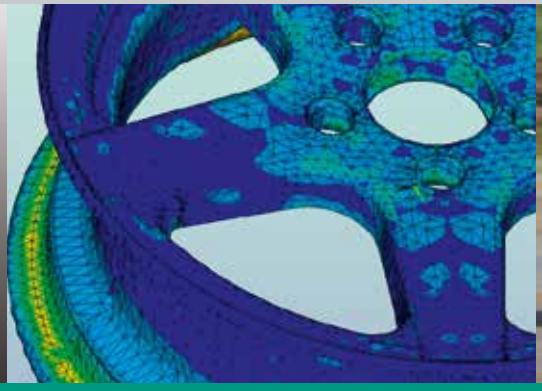
KITe hyLITE

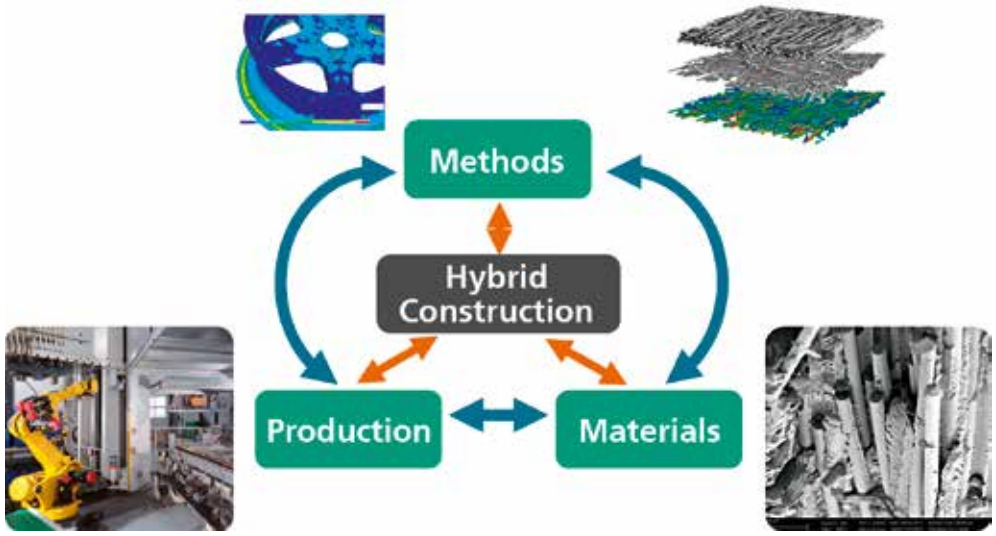




KITe hyLITE

INNOVATION CLUSTER

TECHNOLOGIES FOR HYBRID LIGHTWEIGHT CONSTRUCTION



The aim is to rigorously implement Multi Material Design (MMD) as a means of intelligently combining fiber composite polymers with other materials in order to meet the requirements of specific applications.

Successful implementation of the principles of hybrid construction is only possible by comprehensively examining and assessing the overall system consisting of methods, materials and production.

Bearing the complexity of these topics in mind, the KITe hyLITE innovation cluster was founded as a strong network of partners, which has been promoting an interdisciplinary approach to hybrid construction issues with a focus on composite technologies for years. The core partners are members of the Fraunhofer Gesellschaft and the Karlsruhe Institute of Technology (KIT) and are located in the Freiburg-Karlsruhe-Darmstadt region.

In line with the aforementioned focus on composite technologies, research work within the KITe hyLITE innovation cluster is concentrated on the following processing technologies:

- Long fiber reinforced thermoplastics in (LFT-D), direct processing
- Long fiber reinforced thermosets in the form of sheet molding compounds (SMC) and polyurethane (PUR) fiber spraying
- Resin transfer molding (RTM)
- In situ polymerization based on endless fiber reinforced polyamide 6
- Technologies for handling and preforming textile semi-finished products

Within this context, methods are developed for the design, simulation and characterization of fiber composite technologies. In addition, new material systems are developed while existing systems are refined. These are needed in combination with the aforementioned production technologies in order to successfully introduce fiber reinforced composite materials in hybrid structures into medium-sized and large series applications. These competencies are rounded off by comprehensive experience in the testing, characterization and assessment of the materials named above – knowledge which is essential in order to validate the structural and process simulations and to press ahead with process developments.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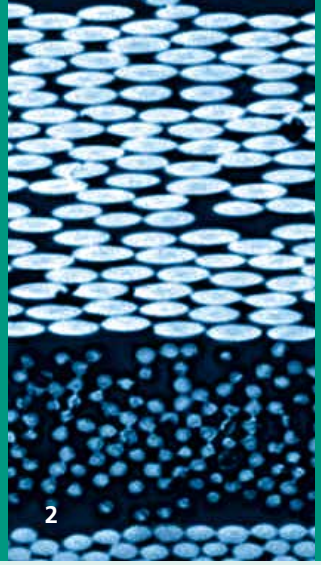
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MATERIALS

In this topic area, »MATERIALS« are analyzed and the properties are modified to meet the needs of the applications. The focus here is on the development of suitable testing concepts for innovative fiber reinforced materials and hybrid composites. Investigations are also carried out to determine which process optimizations can be used to create the optimum composites for specific applications.

Analysis

- Materials testing that accounts for anisotropy, heterogeneity and processing conditions
- Implementation and assessment of standardized tests
- Characterization of microstructural analysis including macroscopic, structurally dependent material parameters
- Fracture surface analysis
- Internal stress analysis

Approach

- Material optimization through the use of additives
- Determination of interdependencies between process parameters (temperature/pressure) and material properties
- Surface modifications for hybrid manufacture

Specific KITe hyLITE examples:

1 Long fiber reinforced thermoplastics (LFT-D)

- Determination of anisotropic properties, temperature and expansion rate dependency of long fiber reinforced thermoplastics
- Computer tomography of long fiber reinforced polymers and analysis of fiber length and orientation distribution
- Fracture surface analysis

2 Resin transfer molding (RTM)

- Determination of process effects on the mechanical properties of RTM and T-RTM components

3 Long fiber reinforced thermosets (SMC)

- Experiments to characterize sheet molded compounds (SMC) in terms of fatigue and fracture behavior in order to exploit the full potential of lightweight designs
- Investigations into the introduction of endless fibers to random fiber reinforced SMC and evaluation of improvements to dynamic and static strength through the addition of endless fiber reinforcements

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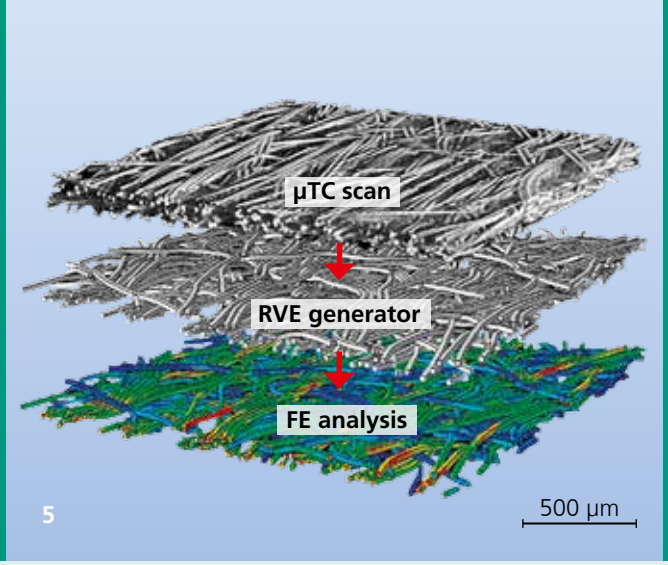

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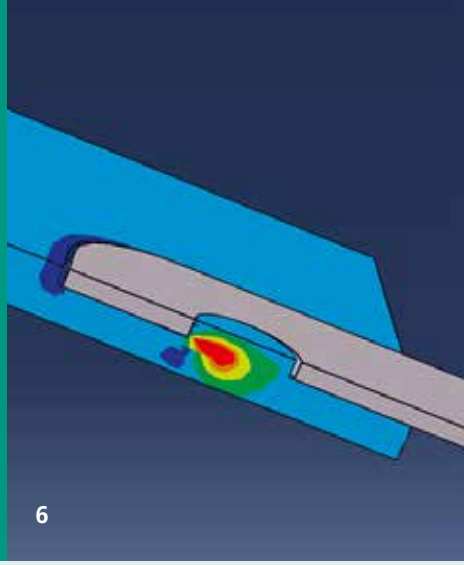

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METHODS

One needs suitable design and assessment »METHODS« in order to fully exploit the potential of lightweight hybrid structures. As the properties of fiber reinforced hybrid composites are very complex, KITe hyLITE utilizes its own assessment methods to model the microstructures of the fiber reinforced composite materials, measure cyclic loads and assess the links between different materials.

Development and implementation of

- Component tests under complex loads: biaxial, static, cyclical, dynamic, operating temperature, environmental media
- Testing concepts as the basis for assessment methods
- Micro mechanical modeling: homogenization, property forecasting, micro structuring, material optimization
- Modified material models (incl. implementation)
- Process and component simulations
- Optimization and assessment methods

Specific KITe hyLITE examples:

4 Durability assessment concept

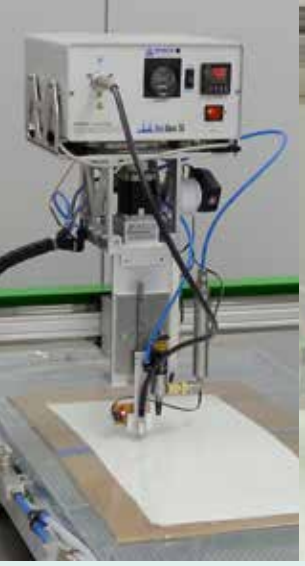
- Further development of an assessment concept for estimating the operating life of components subject to cyclic loads

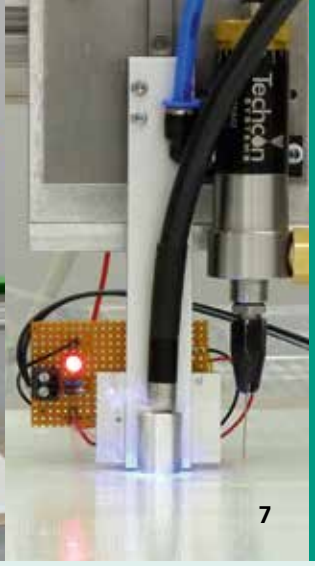
5 Microstructure modeling

- Microstructure modeling of long fiber reinforced thermoplastics to assess creep behavior taking into consideration fiber volume, fiber orientation and fiber length distribution

6 Assessment of hybrid composites

- Development of experimental procedures and modeling approaches for assessing polymer/metal hybrid composites based on their deformation and failure behavior
- Optimization of joining technology for hybrid composites





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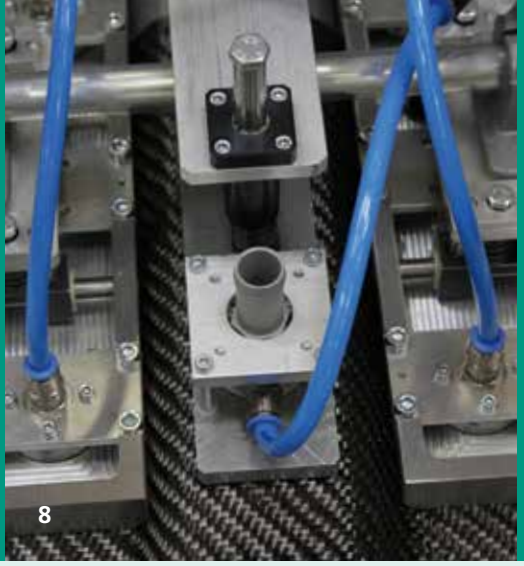

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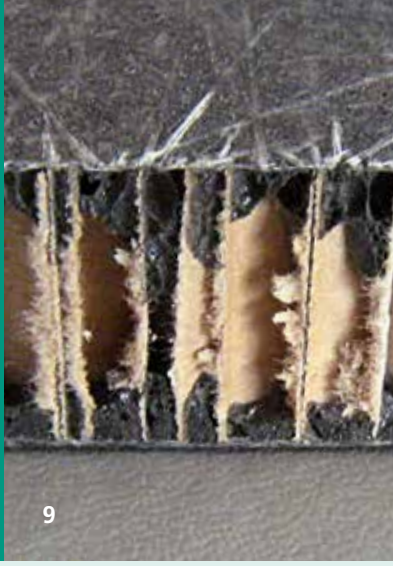

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PRODUCTION

The »PRODUCTION« work deals with the transfer of established or new fiber composite technologies to industrial applications. The focus is on reducing cycle times, increasing functional integration through hybridization and guaranteeing reproducible component quality through the use of consistent automated production processes.

The aim is to establish and strengthen the role of fiber reinforced plastic components in the manufacture of medium-sized and large product quantities, which is why KITe hyLITE research work concentrates on the manufacturing technologies LFT-D, SMC, polyurethane fiber spraying, HP-RTM and thermoplastic RTM.

In addition to the aforementioned process technologies, this topic covers the handling and preforming of dry and bonded textile semi-finished products, as the resin injection process (RTM) places particularly high demands on production.

Specific KITe hyLITE examples:

7 Chemical stitching

- New approach to the fixation of textile semi-finished products in a pre-formed state
- Local introduction of fixing points using adhesives or resins
- Elimination of large areas of binder systems

8 Development of a gripper

- Reproducible handling of textile semi-finished products
- Precise positioning and laying
- Modular, robot-assisted system

9 PUR fiber sprayer

- Robot-assisted system for reproducible introduction of long fiber reinforced polyurethane in tool cavities
- Combination with various core structures for creating sandwich structures
- Demonstration of feasibility using the example of motor unit casings in public transport trains

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