

Equipment

Winding Machine

- Dry and wet winding process with fibre rovings
- 4 CNC-controlled axes
- Impregnating bath and heated mandrels
- Winding length max. 1400 mm, diameter max. 700 mm
- Fibre coils max. 6
- Thread tension up to 50 N

Vacuum Laminating Hot Press

- Processing of dry and wet laminates prepregs and short fibre mixtures
- Evacuatable press chamber
- Path and pressure controllable
- Adjustable pressure $p = 2 - 400$ kN and $T = RT - 400$ °C
- Stampable surface 600 x 400 mm

Prepreg Machine

- Continuous roll-to-roll process
- Coating of 2D-fabrics and UD-tapes
- Application process: Foulard, squeegee, powder spreader
- Working width (width of the fabric) up to 600 mm

Machining Center

- Precision machining of metals and composite materials
- 5-axis simultaneous machining
- Part sizes up to $\varnothing 640$ mm, 500 mm height and max. 1000 kg
- 3D component measurement in the machine

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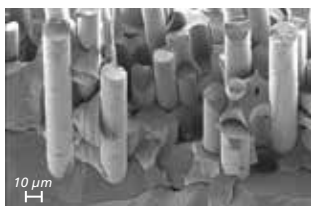
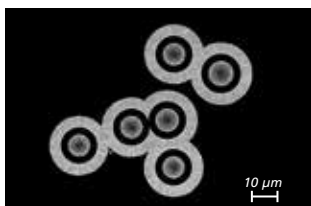
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Center for High Temperature Materials and
Design HTL

Fibre-Reinforced Composite
Ceramics (CMCs)

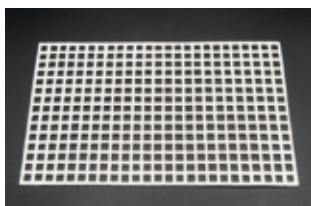


High Temperatures Efficient Solutions

At Fraunhofer-Center HTL, fibre-reinforced composite ceramics (CMCs) are being developed that are characterised by high strength and damage tolerance at high application temperatures $> 1000\text{ }^{\circ}\text{C}$.

Ceramic Lightweight Structures for High Operating Temperatures

CMCs can be used in processes at high temperatures, where energy must be saved as well as CO_2 emissions must be significantly reduced. The use of CMCs enables weight-optimised designs with high stiffness, which represent an alternative to metallic structures. The property potential of oxide and non-oxide CMCs opens up numerous application possibilities in aerospace, mechanical and plant engineering as well as in the chemical industry.



CMC Production

A complete manufacturing chain for CMCs is available at the HTL to produce testable samples and prototypes. Ceramic fibres and fibre preforms developed in-house are used as short fibres, as 2D and 3D semi-finished products suitable for load or as wet preregs. We develop slurry-based matrix systems with which semi-finished fibre products can be well impregnated. The microstructure and the associated subsequent properties are adjusted by factors such as fibre volume fraction, fibre matrix distribution and fibre orientation. Shaping is carried out by partially automated pressing, winding and laminating processes, which allow high reproducibility and are cost-efficient. Thermal treatment steps include debinding, sintering, pyrolysis, graphitisation and melt infiltration. The exact process parameters are determined by thermal analyses and thermo-optical methods. Numerous test methods are available for testing and quality control.

Services

The technology for CMC production at the HTL has a high level of technical maturity to enable prototype production. A wide selection of fibre matrix systems is available, which can be customised for customers. Component production is possible on the basis of material simulations and the lightweight designs derived from them.

- Lightweight solutions with CMCs through thermal and mechanical simulation of high-temperature processes
- Design recommendations for CMC structures
- Hybrid structures through joining and bonding techniques
- Production of ceramic fibres on a pilot plant scale and their processing into textile semi-finished products
- Fibre coatings to increase damage tolerance
- Green production close to the final contour
- High temperature treatments up to $2400\text{ }^{\circ}\text{C}$
- Coatings to increase service life in corrosive atmospheres
- Prototype and small series development
- In-process quality testing