Fraunhofer-Center HTL
is certified acc. to ISO 9001:2015

Service Offering

- **Robot-Assisted 3D Fibre Deposition**
  - Dry / wet depositing process of fibre rovings / tapes
  - Fibre deposit isotensoid and arbitrarily complex
  - 6 CNC-controlled axes
  - Component weight < 65 kg
  - Component size < 1000 mm
  - Traversing accuracy approx. 10 µm
- **Continuous Fibre Coating**
  - Roll-to-roll process
  - Deposition of multiple coatings
  - Coating and thermal treatment in one step
  - Coating thicknesses < 1 µm
  - Fibre throughput > 500 lfm/h
- **Production of 2D to 3D Fibre Preforms**
- **Continuous Production of Tubular Preforms**
- **Production of Small Batches in Series Production**
  - Production of prepregs / preinfiltrated fabric
  - Cutting prepreg and fabric according to CAD data using a cutter
  - Green body production by means of moulds and hot-vacuum presses
  - Thermal processing / sintering also of large components < 0.5 m³

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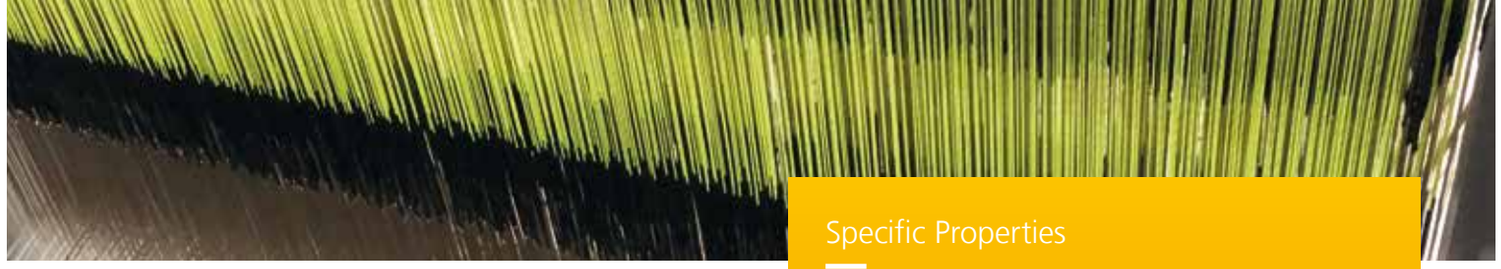
Center for High Temperature Materials and Design HTL

Low-Cost CMCs

Cost-Effective CMCs for Applications up to 1000 °C



Low-Cost CMCs

Damage-Tolerant Ceramics for Operating Temperatures up to 1000 °C

The good corrosion resistance of ceramic materials opens up a wide range of applications in chemical, thermal and energy technologies as well as in aerospace. However, the brittleness of monolithic ceramics often prevents their use under harsh conditions. Fibre-reinforced ceramics (CMCs), on the other hand, offer high damage tolerance. High fracture toughness and elongation at break are achieved through fibre-matrix interaction. However, CMCs have so far been very expensive and can therefore only be used in special applications. At Fraunhofer Center HTL, new types of low-cost CMCs are now being developed.

Fibre Selection and Preform Production

Depending on the application, cost-effective glass, basalt or silicate fibres are selected. For this purpose, textile processes suitable for series production are developed for preform manufacturing. The fibres are arranged according to the load in 2D and 3D structures using the latest textile processing methods:

- Weaving
- Braiding
- Knitting
- Winding
- Fleece process

Specific Properties

Low-cost CMCs are based on low-cost fibres and matrices as well as on automated manufacturing processes.

- Significant reduction in manufacturing costs compared to conventional CMCs
- Application temperatures 300 to 1000 °C
- Design especially for lightweight structures
- Application potential in chemical and process engineering, smelting metallurgy, glass production, power plant and foundry technology

High Temperature Resistant Matrices and Strengths

The selection of the matrix systems is task-specific with regard to the maximum operating temperature and the corrosive load. Suitable matrices are, for example, silicon-containing high-temperature polymers and geopolymers. The incorporation of the matrices into the fibre preforms takes place, for example, in fully automated prepreg processes as a roll-to-roll process.

The polymers can be processed in air. Stable 3D network structures are formed by functional chemical groups. The final treatment by sintering processes leads to thermally highly resistant ceramic matrices even at low process temperatures. Thus, composite strengths of approx. 30 MPa bending strength at elongations of approx. 0.5 % can be achieved. The elongation at break can be further increased by a fibre coating.

Automated Manufacturing and Testing Processes

In contrast to classic CMC production with many time- and energy-intensive high-temperature steps, the overall process for producing low-cost CMCs involves only a few process steps. Known processes from CFRP technology can be used for this. The HTL offers processes from laboratory to pilot scale for the production of prototypes and small series.

A high degree of automation and the linking of all individual steps are possible. An automatable quality control of the products is carried out using 3D computer tomography. By using automatic handling systems, prototypes and also small series can be inspected quickly and cost-effectively. By evaluating micrographs, material defects and rejects can be identified.

Complex laminating mould

3D structural component