Service Offering

- Development of oxide ceramic reinforcing fibers
- Development of functional fibers: Hollow fibers (porous or dense) and two-component fibers
- Dry and melt spinning technology in air and under inert conditions
- Process transfer to the customer incl. support in basic engineering
- Fiber characterization acc. to DIN EN standards
- Development of fiber coatings e.g. for fiber-matrix bonding design

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

Fraunhofer ISC

Center for High Temperature Materials and Design HTL

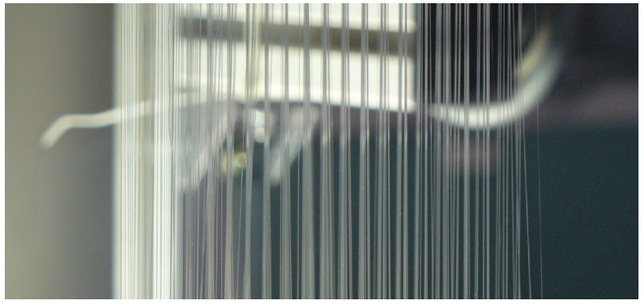
Oxide Ceramic Reinforcing Fibers

Oxide Ceramic Reinforcing Fibers

The mechanical properties of metallic and ceramic materials can be decisively improved by bonding them with ceramic reinforcement fibers. The fibers are embedded in a metal or ceramic matrix to produce MMCs (Metal Matrix Composites) or CMCs (Ceramic Matrix Composites). Due to the fiber reinforcement, MMCs have a significantly higher creep resistance than monolithic metal materials; CMCs have a high damage tolerance and quasiductile material behavior due to the fiber reinforcement.

To fulfill their function, the reinforcing fibers have a significantly higher tensile strength than the matrix material. In CMCs, a special design of the fiber-matrix connection or the fracture behavior of the matrix also ensures maximum energy dissipation at fracture.

Oxide ceramic fibers exhibit excellent resistance to oxidation. They are characterized by outstanding high-temperature strength and creep resistance and are suitable for continuous use at temperatures above 1,000 °C.



Multifilament spinning

Customized Fiber Development

Fraunhofer Center HTL develops tensile oxide ceramic reinforcing fibers with customer-specific application and processing properties:

- Fiber composition: mullite, corundum, etc.
- Maximization of throughput
- Fiber diameter: approx. 8 to 100 µm
- Cross section: round or profiled
- Length: continuous or short fibers
- Porosity: 0 to 30 vol%
- Stiffness: 100 to 350 GPa
- Creep rates: < 1 % elongation in 1,000 h at 1,100 °C / 200 MPa
- Filament count per roving: 1 to 1,500

Scaling

Depending on requirements, the fibers can be offered in laboratory quantities up to pilot scale. A special fiber pilot plant with a production capacity of approx. 1,000 kg per year is available for pilot production. If required, the fibers can be coated cost-effectively by means of wet-chemical processes. With state-of-the-art textile machines, the fibers can also be further processed into 2D or 3D preforms. Various weaving and braiding systems are available for this purpose.

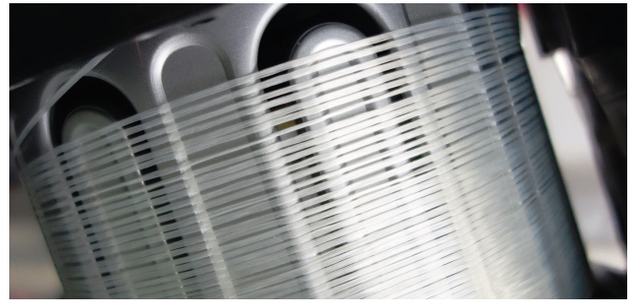
The mechanical and thermodynamic fiber properties resulting from the application requirements can be calculated in advance using computer-based methods. Depending on the complexity of the development task, this can be carried out directly for the customer or within the framework of funded projects.

Fiber pilot plant in Bayreuth

Manufacturing Process

The ceramic fibers are synthesized from metal-organic aqueous solutions or colloid-dispersed precursors, which allow homogeneous mixing of the components on a nanometer scale. With the addition of spinning aids, the solutions can be spun in a dry spinning process to form green fibers, which can be converted by temperature treatment into ceramic fibers of the desired mineralogical composition.

For novel oxide compositions, the synthesis and preparation on a laboratory scale will be worked out first. The proof of spinnability is followed by a feasibility check of multifilament spinning. If fibers with the desired properties are obtained, various options are then available for scale-up.



Prewinder