

Key areas of work

- ◆ Thermo mechanical testing of ceramic matrix composites at temperatures up to 2200 K
- ◆ Characterization of the mechanical behaviour of monolithic ceramic, functional ceramic and porous ceramic
- ◆ Development of new testing procedures in mechanical testing
- ◆ Fiber reinforced light metals for aero engines
- ◆ Cooperation in the development of technical rules and standards (DIN NMP 291, CEN/TC 184)
- ◆ Customized mechanical testing

BAM, division V.2 is approved by DAP Deutsches Akkreditierungssystem Prüfwesen GmbH according to DIN EN ISO/IEC 17025:2000 as an accredited testing laboratory.



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Federal Institute for Materials Research and Testing (BAM)

Division V.2

Mechanical Behaviour of Materials

Working group

Composite Materials

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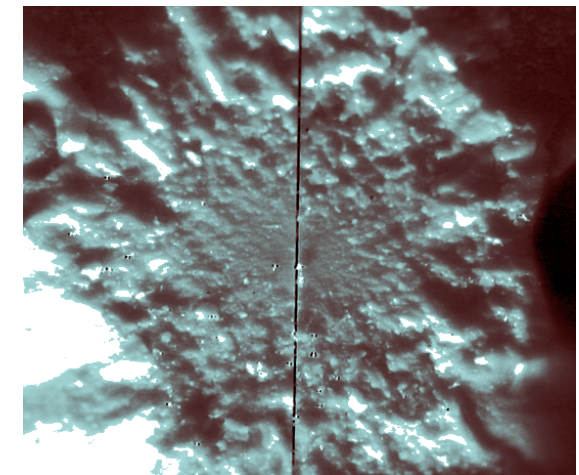
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Federal Institute for
Materials Research
and Testing

Determination of Flexural Strength



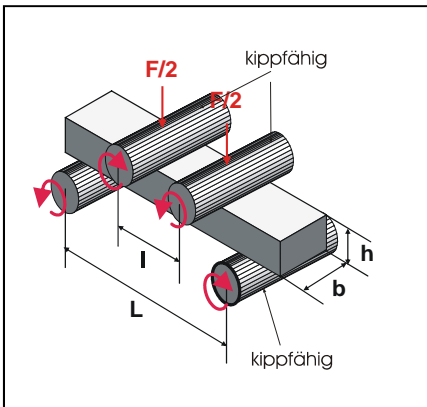
Origin of fracture

**Working Group
„Composite Materials“**

Basic principles

The determination of nominal flexural strength of advanced monolithic technical ceramic materials and ceramic composite materials takes place in a loading jig for four-point bending. This set-up is mostly preferred to the three-point bending test since an extended region with constant bending moment exist between the inner loading rollers (I). Due to statistic effects, the strength values in four-point bending are less than in three-point bending.

The scatter in the strength of ceramic materials is larger than that of metals. This scatter is caused by the scatter of flaw size in the material. Further statistical evaluation of results is required for design data acquisition (DIN EN 843-5).



Four-Point bending jig

The bending strength is calculated by the following equation

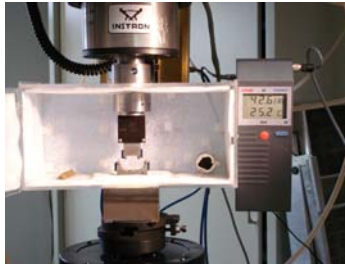
$$\sigma_f = \frac{3 \cdot F \cdot (L - l)}{2 \cdot b \cdot h^2}$$

F_{\max} — load at failure

Procedure

Measurement at Room Temperature

Different bending jigs exist for room temperature measurements in dependence of dimension and kind of ceramic materials.



Four-Point bending jig according to DIN EN 843-1

Determination of Flexure Strength according to DIN EN 843-1 for monolithic ceramics is carried out with samples of the dimension 3 x 4 x 45 mm. Loading rollers have an inner span of 20 mm and an outer spans of 40 mm.

For ceramic laminates and substrates a loading jig was designed with inner span of 5 mm and outer span of 10 mm.



Four-Point bending jig for ceramic laminate and substrates

Measurement at High Temperature



Bending jig located in a furnace

The temperature dependency of flexure strength can be determined up to 1300°C in air with forces up to 2 kN.

The bending jig is made of SiC.

Standards

Determination of flexural strength of monolithic ceramics at room temperature

- ◆ DIN EN 843-1
- ◆ ASTM C 1161

And at high temperature

- ◆ DIN EN 120-1
- ◆ ASTM C 1211

Determination of flexural strength of ceramic composites at room temperature

- ◆ DIN EN 658-3
- ◆ ASTM C 1341

Statistical analysis (Weibull)

- ◆ DIN EN 843-5