

## 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

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## Strength at multiaxial loading



Origin of Fracture

**Working Group  
„Composite Materials“**

BAM, division 5.2 (old V.2) is approved by DGA Deutsche Gesellschaft für Akkreditierung mbH according to DIN EN ISO/IEC 17025:2005 as an accredited testing laboratory.

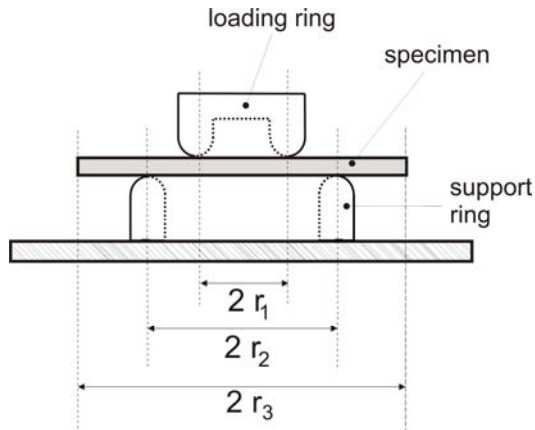


DGA-PL-2614.16

In components very often multiaxial stresses occur. Therefore different experimental methods were developed to create multiaxial stress states in test specimens.

### Ring-on-Ring-Test

A disk-shaped specimen is supported by a ring and loaded by a concentric ring of smaller diameter.



Test arrangement for the ring-on-ring test

The stress distribution is given by:

$$\sigma_i = \frac{3Fz}{2\pi t^3} * D_i(\rho, a, b, \nu)$$

$$a = \frac{r_1}{r_2} \quad b = \frac{r_3}{r_2} \quad \rho = \frac{r}{r_2}$$

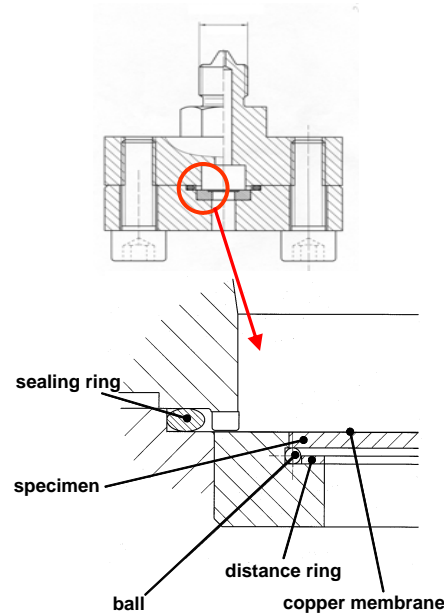
- F applied load
- t thickness of the disc
- $\nu$  Poissons ratio

Experiments and analytical calculations have shown that stress magnification of up to 20% can occur opposite the inner ring.

To avoid this stress magnification efforts were undertaken to develop alternative test methods like:

### Burst-Test

A disk-shaped specimen is supported by a ball bearing race and loaded by hydrostatic pressure. By this test arrangement the maximum of stress appears in the middle of the specimen and therefore also the origin of fracture.



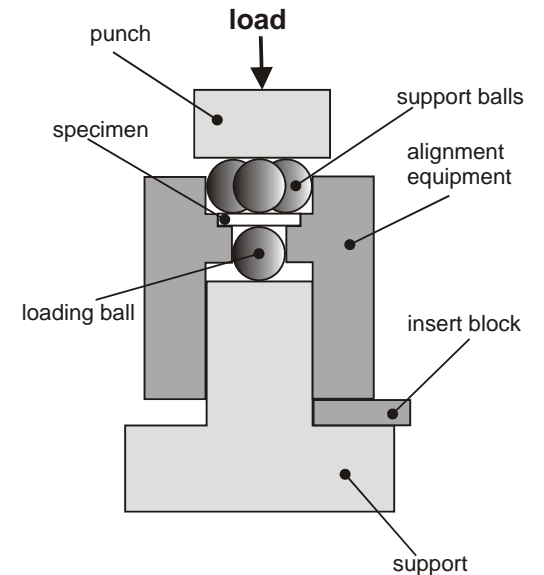
Details of specimen support in the pressure chamber

For following specimen geometry loading devices are available:

h [mm]	d [mm]			h-thickness d-diameter
	8	9.5	18.5	
1	X	X	X	
0.67			X	
0.66	X	X	X	
0.63	X	X	X	
0.38	X	X	X	

### Ball-on-Three-Ball-Test

A disk-shaped specimen is supported on 3 balls. This balls form an equilateral triangle. The load is initiated centrally by a load ball. The maximum tension stress appears vis-à-vis the load ball.



Experimental set-up for the ball-on-three-ball- test

#### Standards and references:

##### Ball-on-Three-Ball-Test:

- ◆ Patent AT 414 714 B; Austria 2004 (R.Danzer et.al.: Procedure and equipment for determination of strength of brittle materials)

##### Ring-on-Ring-Test

- ◆ DIN EN 1288-5 Determination of strength of glass - part 5: Ring-on-Ring-Test at disk-shaped specimen with small testing surface