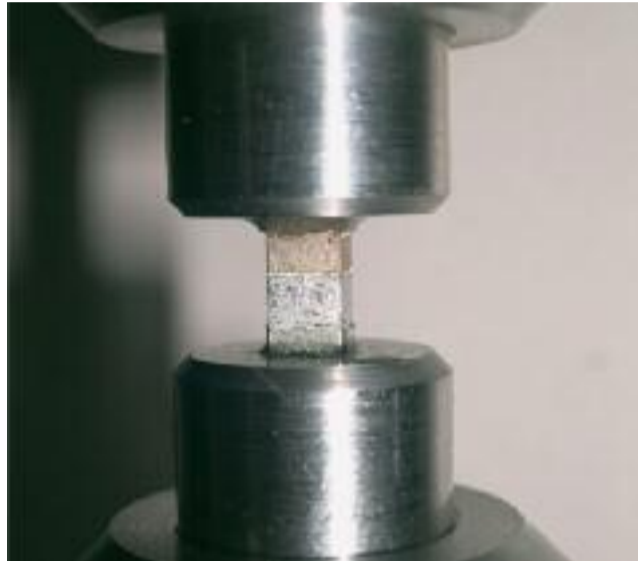


# Mechanical Characterisation of Ceramics, brittle Materials and Components

## Services offered by

Empa, Swiss Federal Laboratories for Materials Science and Technology  
Lab for High Performance Ceramics, Group Ceramic based Composites  
Überlandstrasse 129, CH-8600 Dübendorf, Switzerland

## Materials



Tensile strength test of a Metal-Ceramic joint

### Ceramics

- monolithic
- reinforced (with particles, whiskers, fibers, nano-fibers, CNT)
- conductive, non-conductive, piezo-electric

### Composites

- ceramic-ceramic (CMC)
- metal-ceramic (MMC)

### Ceramic laminates

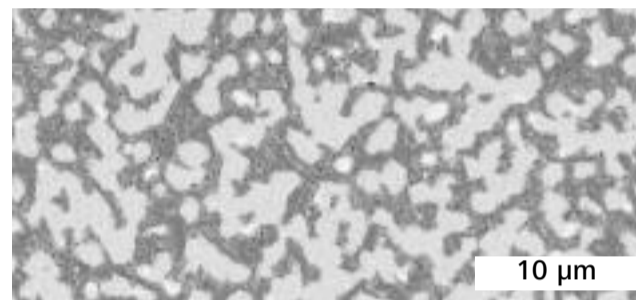
- macro (e.g. wear parts)
- micro (e.g. sensors)
- coatings

### Joined materials (brazed, glued)

- ceramic with ceramic
- ceramic with metal

### and many more, e.g.

- porcelain (e.g. isolator)
- glass (e.g. accessories, controls, instruments)
- long fibers
- porous bodies and foams
- green-bodies



BSE:  $\text{Si}_3\text{N}_4$ - $\text{MoSi}_2$  composite



Ceramic laminate. The white outer layers have a thickness of  $\sim 50 \mu\text{m}$ .

## Properties



Lifetime test on piezo-electric sensor element under humid operating condition.

### Strength up to 1'500°C

- 3-point and 4-point bending
- biaxial flexural (ring on ring)
- ball-on-three-ball (small discs)
- C-ring
- shear

### Fracture toughness

- SEVNB: Single Edge V-Notched Beam up to 1'500°C
- SCF: Surface Crack in Flexure
- SEPB: Single Edge Pre-cracked Beam
- edge chipping

### Young's modulus, Shear modulus, Poisson's ratio

- natural frequency up to 1'000°C
- bending up to 1'500°C (Young's modulus)
- instrumented indentation (Young's modulus)

### Hardness

- Vickers and Knoop
- dynamic hardness

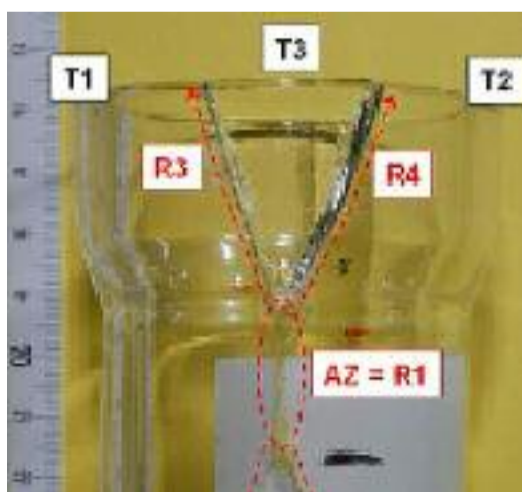
### and many more, e.g.

- Lifetime, e.g. subcritical crack growth under
- static or cyclic load
- constant stress rate
- creep resistance up to 1'600°C
- tensile load
- thermal shock resistance



Thermo-mechanical characterization of Solid Oxide Fuel Cell component

## Complementary expertise



Failure analysis on a flow meter

### Development of ceramic based composites

#### Failure analysis

(fractography)

#### Microstructural analysis

#### Thermo-mechanical characterization

#### Oxidation and corrosion resistance tests

(various gas atmospheres, up to 1'500°C)

#### Detection of crack initiation

(acoustic emission)

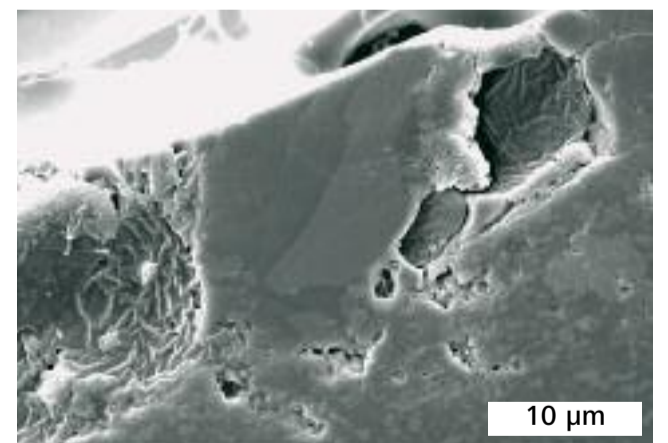
#### Development and validation of mechanical tests

(methods, equipment, standards)

#### Statistical analysis

(mainly Weibull)

#### Education and training of staff



Damage on  $\text{Si}_3\text{N}_4$  based composite test sample after severe oxidation test

## Your advantage



STS 151

Professional expertise for consulting, testing, analysis and use of brittle materials.

## Your contact

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