Influence of metallisation on the mechanical behaviour of Low Temperature Co-fired Ceramics under biaxial loading

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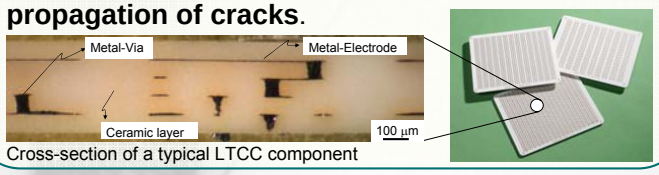
Introduction

Low Temperature Co-fired Ceramics (LTCCs) are 3D micro-network of metal structures embedded within a glass-ceramic substrate. They are used as **high precision electronic devices** (*e.g.* mobile and automotive technologies).

The different **internal architectures** can **influence** the **strength reliability** of the LTCC and its expected lifetime.

Motivation

The aim of this work is to study the **mechanical strength** of LTCCs under biaxial loading and investigate the **effect of metallisation on the propagation of cracks**.



Cross-section of a typical LTCC component

Experiments

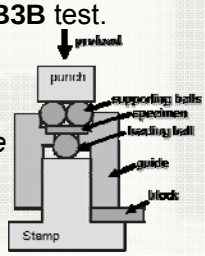
The mechanical strength is determined in ≈10×10×0.4 mm³ plates using the **B3B** test.

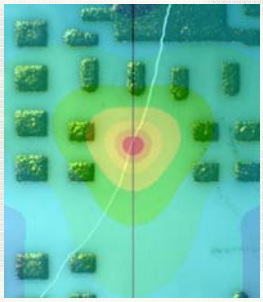
Testing conditions: 0.5 mm/min, 40% RH and 25°C.

The failure stress (*equiv. tensile stress*) is calculated with FEA:

$$\sigma_{eq,max} = [2.58 - 0.67 \cdot (t/t_0 - 1)] \cdot \frac{P}{t^2}$$

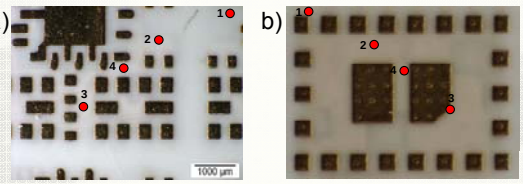
P = Failure load (N), *t* = thickness (mm), t_0 = 0.43 mm





Maximal stress distribution around location 2.

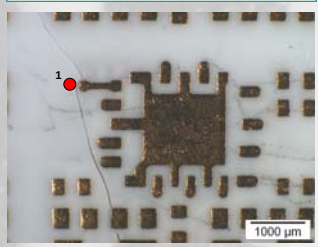
The strength of both a) the **upper side** and b) the **lower side** of the LTCCs is evaluated.

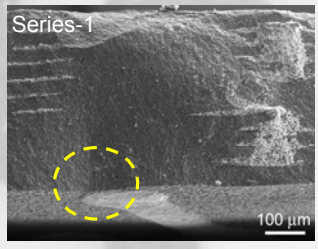


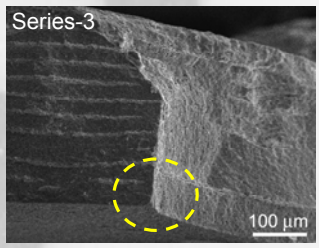
Different locations (*e.g.* vias, metal-pads) are tested and compared to bulk LTCC.

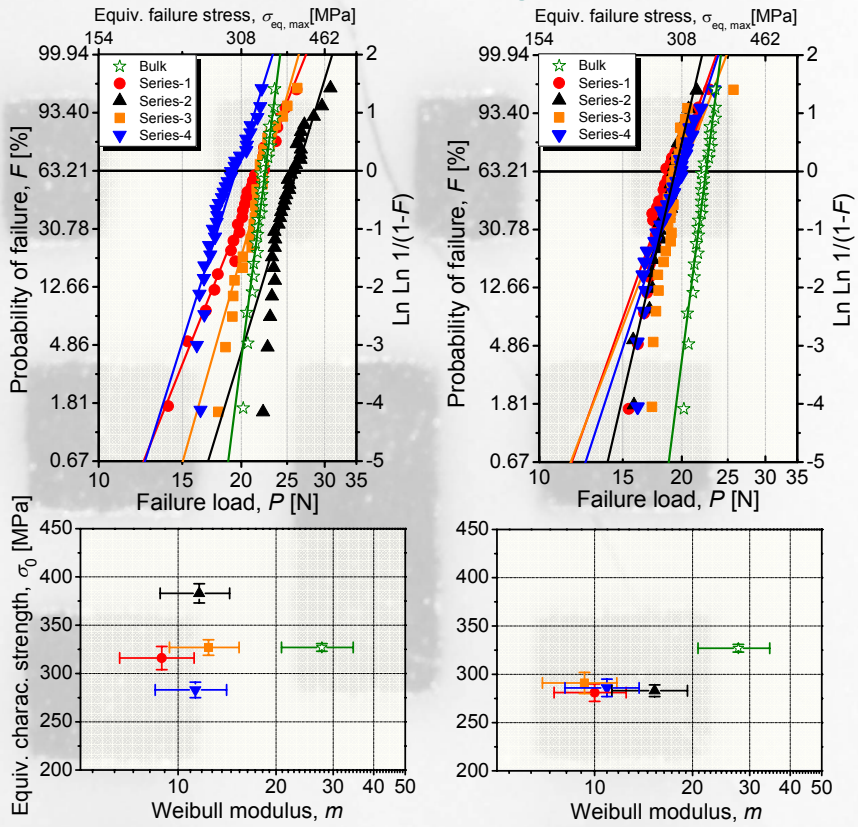
Mechanical strength results

Fracture features of tested LTCCs with the upper side under tension



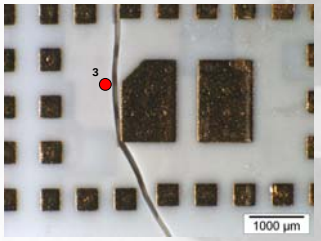


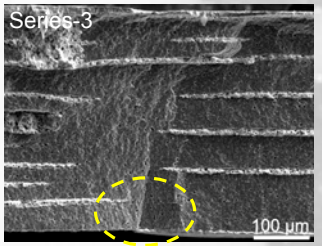


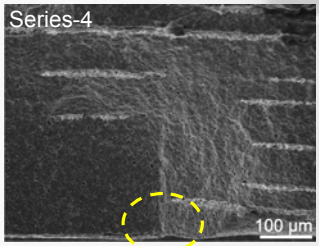


Weibull diagram of LTCC components und bulk material tested under biaxial flexure.
The characteristic strength, σ_0 (*F*=63.21%) is also plotted versus the Weibull modulus, *m*.

Fracture features of tested LTCCs with the lower side under tension







Fracture origin marked with yellow circle.

Summary

+ The **mechanical strength** of LTCC components depends on whether their upper or lower side is put under tension.
+ There is also an **influence of the surface feature** (*i.e.* metal pad, electrode, via) **on the** biaxial **strength** distribution.
+ The **internal architecture** of the component has an effect on the **crack path**, **influencing the strength reliability**.

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