The Effect of the Firing Temperature on the Properties of LTCC

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Abstract

Low-temperature cofired ceramics (LTCCs) technology is used for substrates for multilayer ceramic circuits, mainly for telecommunications, automotive, and medical applications. In recent times LTCCs were also recognized as useful materials for producing complex 3D structures with buried cavities and channels (so-called - micro-electro-mechanical systems (MEMS)). Most of LTCCs are glass-ceramic compositions. These glass-ceramic compositions are usually designed to yield a partial glass crystallization during the firing, which then minimizes the amount of glass phase in the composites and influences the mechanical and electrical properties of the glass-ceramic materials. Driven by the needs of the target application the interactions of different glasses with ceramic fillers during firing and the phases which crystallize from the glasses were extensively studied.

The main physical properties of commercially available LTCCs which are processed using the parameters specified by the producer are available in datasheets and other open literature. However, the production of large or complex 3D LTCC structures requires different firing procedures. Those unconventional firing processes affect the final functional properties of the LTCC material. To the best of our knowledge there is not much data available in the open literature about the influence of different firing conditions, such as firing temperature, on the microstructure, phase composition and consequently on the functional properties of the LTCC.

Background

The Slovenian Research Agency is acknowledged for its financial support of the projects "Ceramic materials for 3D structures and study of functional properties" (J2-8616), the Young Researcher project 100-009-310145. The financial support of the CoE NAMASTE is gratefully acknowledged.

Conclusions and applications

The influence of firing temperatures on the phase composition, microstructure and biaxial flexural strength of the LTCC was investigated. The investigated DuPont 951 LTCC is composed of Al2O3 particles and the glass phase. At 675 °C the LTCC starts to densify after the "liquid glass" is formed. Close to this temperature the particles of anorthite crystallize on the surface of the Al2O3 particles. The amount of anorthite increases with the increasing firing temperature or time until it reaches the plateau value of around 22 w. % at 950 °C. The amount of glass is reduced accordingly. The biaxial flexural strength of the LTCC material fired at 800 °C is around 135 MPa and increases to ~ 220 MPa at 850 °C. The additional improvement of the biaxial flexural strength up to ~300 MPa was obtained between 850 and 900 °C when the anorthite crystallizes on the surface of the alumina particles. For the material fired at higher temperatures only small if any improvement of biaxial flexural strength can be observed.

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