

Preliminary investigations of LTCC piezoelectric thick film devices

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Key words: Piezoelectric thick film, PZT thick film, LTCC, Low Temperature Cofire Ceramics, Microsystem

ABSTRACT

Low temperature co-fired ceramics (LTCC) technology has already been shown to be compatible with screen printed piezoelectric thick films (TF). The screen-printing - and LTCC technology are well suited for miniaturised and complex devices and the combination of the technologies can result in smaller and more integrated devices, which in some cases can be superior to the existing ones.

The LTCC structures are manufactured by a lamination process of several layers of green ceramic tape. Each layer can be printed in parallel and afterwards put together in an aligned stack for firing. The LTCC technology is therefore well suited for complex structures with vias between the layers, and even 3D structures with cavities, channels etc. for example for transporting liquids. 850 °C is a standard sintering temperature within the LTCC technology. Chemical compatibility investigations have been carried out on several LTCC substrates with alumina as reference, and one particular LTCC material has been found to be very promising.

Test devices of various generic designs including membranes and cantilevers with piezoelectric thick film have been manufactured and afterwards preliminary characterised. In addition a possibility of using PZT thick films together with LTCC for acoustic transducers has been presented. A specific diffusion barrier layer has been introduced and found to be successful in all of the tested structures.

The devices have been characterised using several methods. The ferroelectric activity of the piezoelectric material has been determined by the Sawyer-Tower setup. Moreover d33 meter, impedance analyser and pulse echo system (in case of the acoustic transducers) have been utilized in order to measure and indicate the piezoelectric properties of the test devices. The d31 coefficient of the PZT thick films has been measured using cantilever structures and optical profilometer.

The presented work has demonstrated that piezoelectric thick films can be successfully integrated into LTCC devices addressing variety of solutions and the tested structures can be applied to a number of different applications. This includes microsystems (micro-valves, micro-pumps), integrated sensors (e.g. pressure sensors), actuators (micro-positioning) and even multi-element acoustic transducers.