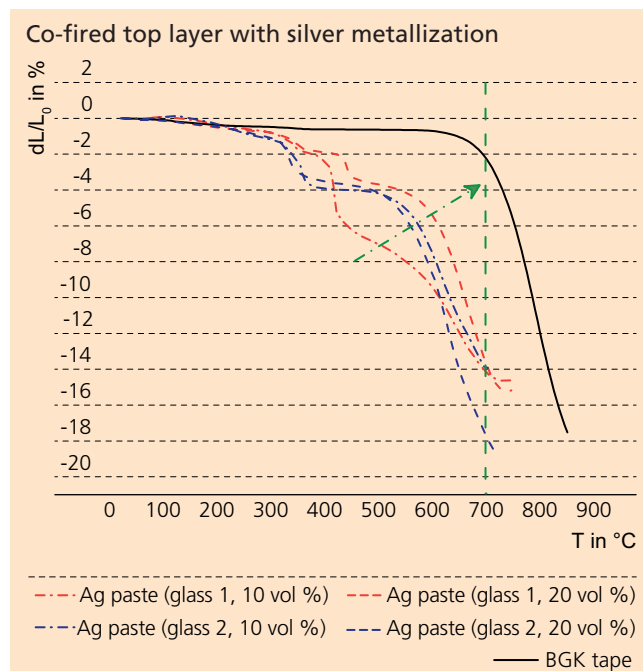


## FORM-STABLE LTCC MODULES THANKS TO IKTS-SILVER PASTES

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LTCC technology on the basis of ceramic tapes provides a wealth of design possibilities for integrating active and passive components into complexly shaped 3D architectures by lamination of planar substrates and bonding. A major limitation in LTCC processing is the well-known substrate warping effect often induced by silver metallization. It is strongly dependent on the specific LTCC composition and silver paste in use but frequently occurs as a result of unconstrained sintering of LTCC substrates with silver metallization. The mechanisms/causes of warpage include constrained tape shrinkage due to the sintered paste, Ag diffusion out of the paste, the crystallization thereby promoted, and thermal expansion mismatch. In order to avoid this deformation, LTCC manufacturers apply constrained sintering technology either by use of sacrificial tapes or by pressure-assisted sintering, which is time-consuming and expensive. Fraunhofer IKTS has developed silver pastes that suppress the warpage mechanisms observed and described by numerous authors. Exemplarily for the Fraunhofer IKTS anodically bondable tape "BGK tape", silver pastes were analyzed in terms of their material chemistry and sintering kinetics and were adapted to the sintering behavior of the tape material. To that end, the chemical composition and the amount of the glass phase in the paste were varied systematically. Silver diffusion was detected and evaluated by SEM and EDX on polished cross sections of sintered samples. Based on the results, the glass composition and amount were specifically adapted to the anodically bondable tape. Silver inner layers, top layers, and via metallizations can now be applied to the LTCC without the substrate showing any warpage after unconstrained sintering in air. The obtained know-how also allows the adaption of screen-printing pastes to other tape compositions.

Silver pastes for screen printing on anodically bondable LTCCs are available. Paste compositions can be adapted to the characteristic sintering behavior of the tape to minimize warpage.



The best results are observed for Ag pastes with a shifted maximum densification temperature ( $T > 700\text{ °C}$ ). Co-firing was optimized to suppress the Ag diffusion almost completely with a combined temperature profile (TP3) comprising slow binder burnout and a silver co-firing step at high heating and cooling rates.

- 1 Doctor blade pilot plant.
- 2 Resistivity measurement.