Influence of the temperature distribution on the thermal resolution of a miniaturized ceramic differential scanning calorimeter

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This study reports on a simulation based optimization of the thermal resolution of a miniaturized ceramic differential scanning calorimeter (DSC-Chip). This chip is a fully functioning DSC apparatus. It includes furnace, sample and reference temperature sensors as well as a crucible, all together in a size of only 39 mm x 11 mm x 1.2 mm. Despite its small size, its calorimetric properties are comparable to conventional DSC apparatuses [1-3]. The DSC-Chip is fully manufactured in Low Temperature Co-firing Ceramics technology (LTCC).
In DSC analysis, a high thermal resolution and a homogeneous temperature distribution within the analyzed sample are related. Therefore, the temperature distribution inside the crucible zone of the DSC chip was optimized. Due to the reduction of the thermal mass and the variation of the width and distance of single meanders of the screen-printed heater conductor, the heat output could be adjusted to form a temperature field with a 30% improvement of the temperature homogeneity within the crucible zone. Infrared camera images of real structures, which were manufactured based on these results, validated the simulated temperature distribution. Test results obtained from Dotriacontane showed an increased thermal resolution of 60% compared to the initial structure with 40%. Co-beneficial is the reduced power demand from 1.52 W to 1.04 W to reach 156.6 °C with a heating rate of 50 K/min.

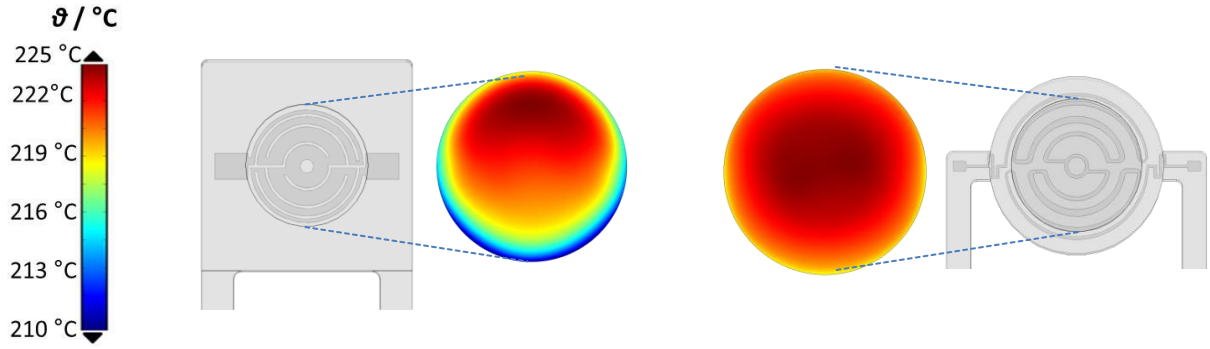

Fig. 1: Simulated temperature distribution inside the crucible of the former initial structure (left) and the recent optimized structure (right)

References:

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