Nucleation and Crystallization in LAS Glass Ceramics: Recent Advances in Understanding Fundamentals Based on Nanostructure Diagnostics

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Abstract

From the base glass system Li2O-Al2O3-SiO2 (LAS), glass ceramics with low- or zero thermal expansion can be derived. They are of highest economic interest, especially because of their very good resistance to thermal shock, and are widely used for manifold commercial products, such as cooktop panels or large telescope mirrors.
Although the synthesis of such materials is state-of-the-art since decades, the fundamental principles of nucleation and crystallization of these LAS glasses are still not fully unraveled.

Based on techniques such as analytical transmission electron microscopy including energy-dispersive X-ray spectroscopy, X-ray diffraction and X-Ray absorption spectroscopy, we present new insights on the role of the nucleation agents ZrO2, TiO2, and the – usually applied - combination of both, on the course of crystallization within LAS glasses. The analyses of samples from different stages of annealing time at a fixed annealing temperature enabled the study of the temporal course of nucleation and crystallization within the LAS base glass. Coordination changes of the nucleation agents are monitored and interpreted, as well as nano- and microstructural changes within the LAS glass during the crystallization process - from the amorphous glass over the formation of first phase-separation droplets, to the precipitation of nanocrystals of the nucleation phases and, finally, to the subsequent growth of the aspired LAS crystals.
Furthermore, effects of a batch simplification on the crystallization behavior and microstructure formation in LAS glasses with ZrO2 as nucleation agent will be shown and discussed.

Keywords: LAS, nucleation, crystallization, TEM, XAS

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