On the search for appropriate nucleating agents in BaO-SrO-ZnO-SiO2 glasses

Katrin Thieme*†[1], Tilman Zscheckel[1], Christian Thieme[2], and Christian Rüssel[1]

[1]Otto Schott Institute of Materials Research, Jena University – Fraunhoferstraße 6, 07743 Jena, Germany

[2]Fraunhofer Institute for Microstructure of Materials and Systems IMWS – Walter-Hülse-Straße 1, 06120 Halle, Germany

Abstract

Recently, a new crystalline phase with the formula Ba1-xSrxZn2Si2O7 was found which shows a very low or even negative thermal expansion behavior. However, since this phase shows a pronounced contraction in the direction of the crystallographic b-axis while it expands in a- and c-direction, the thermal expansion is highly anisotropic.
In BaO-SrO-ZnO-SiO2 glasses, this solid solution phase can be precipitated in high concentrations. However, these glasses normally tend to surface crystallization and due to the strong anisotropy of the coefficient of thermal expansion of this phase, the obtained glass-ceramics often show micro cracking limiting the preparation of larger samples. In order to overcome the as mentioned difficulties, the crystallization mechanism has to be switched to bulk crystallization by the use of appropriate nucleating agents and a high number density of volume crystals has to be precipitated.
This paper describes the effect of different additives such as P2O5, SnO2, or CeO2 on the crystallization behavior and their ability as nucleating agent was studied. Phase formation and microstructure of the glass-ceramics were investigated using thermal analyses, X-ray diffraction, as well as scanning electron microscopy. Moreover, the thermal expansion behavior obtained from dilatometry was correlated with the microstructure. The appearance of micro cracks can be attributed to certain crystallographic directions using electron backscatter diffraction.

Keywords: Glass ceramics, nucleation, thermal expansion, microstructure

*Speaker
†Corresponding author: katrin.thieme@uni-jena.de