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Sintering, crystallization shrinkage and formation of crystallization induced porosity in model diopside glasses

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Abstract: Since the density of the crystalline phases is higher than that of the corresponding supercooled melts the crystallization process leads to shrinkage, stress accumulation and/or formation of crystallization induced porosity. These phenomena are very important for the metalworking and crystallization of polymers; they are also observed at the slow cooling of high-viscosity melts, studied in geology and even in astronomy. However, these variations in the density and their effect on the structure and the properties of final materials are not yet well elucidated in the manufacture of glass-ceramics.

Here are summarized results for the reached degree of sintering, as well as for the crystallization-induced shrinkage and crystallization-induced porosity in a series of sintered diopside glass-ceramics. The data were obtained mainly by isothermal and non-isothermal experiments with optical dilatometer, DTA and XRD, combined with the evaluation of resulting structures by computed tomography and SEM.

It is discussed that the sintering and the subsequent crystallizing shrinkage stop after the formation of surface crystalline shells with a critical thickness in the sintered particles. Than in the centers of grains starts the creation of near spherical crystallization pores, which are well distinguished from the residual inter-granular residual pores. This leads to an increase of the porosity with rise of the size of initial glass fraction and with the crystallization trend of used glass.