Influence of nucleation and crystallization on the rheological properties of lithium disilicate melts.

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Abstract

The rheological properties of pure, nucleated and partially crystallized lithium disilicate melts may be described by various rheological features such as Newtonian and non-Newtonian viscosity, stress generation modulus, stiffness and stiffness resistance (brittleness) and the critical deformation rate at the first high-temperature crack. These quantities are determined from the stress-strain curves of cylinder compression experiments on the basis of equal (Newtonian) equilibrium viscosities (isochomal conditions). The flow-, brittleness- and stiffness-parameters show a characteristic non-linear decrease with increasing deformation rates. This "shear thinning" behaviour shows one step in the case of single-phase glass melt and two independent steps in the case of partially crystallized two phase-samples. This behaviour can be successfully described by a sum of two separate equations on the basis of a recently developed flow equations for stress induced changes of viscosity and brittleness of glass melts. The first step of the viscosity and brittleness decrease, within the range of low deformation rates, is caused by a "suspension effect"' of the homogenously distributed crystals and the second step, at higher deformation rates, by the non-Newtonian flow behaviour of the glass melt matrix. The "suspension effect" is due to a flow-orientation mechanism of the suspended crystals and varies with their sizes, their shapes and number. The non-Newtonian flow behaviour of the pure glass matrix is not only a consequence of viscoelasticity but is also based on the orientability of flow units because the character of the flow curves of single-phase glass melts with different degrees of structural interconnectivities is changed in a similar way as in two phase lithium disilicate melts with different degrees of deviation from the isometric spherical habit of the crystals.