High temperature viscosity of the vitreous phase into porcelain stoneware bodies

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Abstract

Porcelain stoneware tiles contain 60% to 75% of vitreous phase. Its viscosity at high temperature is crucial to understand the vitrification path, the viscous flow sintering kinetics and the pyroplastic deformation of tiles. Nevertheless, these behaviours depend on both the viscosity of the liquid phase formed by the melting of feldspars (and other minerals) and the viscosity of the body made up of a suspension of crystals dispersed in the melt. Fundamental theoretical background already exists, along with semi-empirical constitutive laws on the viscous flow sintering, the glass densification, and viscosity of liquids and melts. Since different approaches are needed to measure/estimate the two viscosities, the best model for ceramic tiles has been defined by contrasting experimental data with calculated viscosities. The parameterization is based on both chemical composition of the liquid phase and persistence of crystal phases in the melt. Further variables (such as porosity, particles size and shape) play a significant role that is to some extent modelled. Existing models for high temperature viscosity of glasses and melts take into account a large number of oxides and can be applied to a wide range of composition. However, the maximum concentration of alumina considered by these models is too low compared with the content in the vitreous phase of ceramic systems, thus generating a significant error between the calculated and the measured viscosities. Although based on a lower number of oxides, models used in petrology account for alumina levels matching those of the systems of interest. In this contribution, models set up for glasses are used to predict the viscosity at high temperature of the vitreous phase present in ceramic bodies in order to explain their different sintering behaviours. Examples are provided for porcelain stoneware tiles, compared with vitreous china and porcelain bodies.

Keywords: Vitreous Phase, High temperature, Viscosity, Porcelain Stoneware.

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