"Ceramizing the Future for a Sustainable Society"
June 17 - 21, 2018 / Foz do Iguaçú - PR - Brazil
ICC7
7th International Congress on Ceramics
& 62º Congresso Brasileiro de Cerâmica

VISCOUS FLOW SINTERING OF LARGE CERAMIC SLABS

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Abstract

The production of porcelain stoneware tiles is moving towards ever-larger size, from 320x160 to 480x180 cm (from 5.1 to 8.6 m2) and thickness from 3 to 20 mm (up to 400 kg each slab). The driving force of this product-process innovation is twice: gain in efficiency and productivity from highly standardized manufacturing plants as well as commercial return from value added, versatility and new application fields (e.g. façades, furniture, alternative to ornamental stones and wood slabs). Nevertheless, this technological advancement is stressing the requirements of uniform densification and minimal deformations during firing. It is a hard task, since porcelain stoneware is sintered by partial vitrification, through viscous flow of an abundant liquid phase formed at high temperature. Such a process must be kept under strict control to achieve the desired properties of final products and prevent defects induced by pyroplasticity. The present contribution will overview the evolution of microstructure and phase composition of porcelain stoneware with temperature and soaking time. Industrial firing schedules let feldspars to melt quickly (K-feldspar>plagioclase) while quartz is only partially dissolved at the highest temperature. Once formed, mullite is gradually dissolved, though by a decreasing rate, making the melt increasingly peraluminous. The melt viscosity lowers rapidly up to 1200°C, but tends to increase slowly during soaking. These physical and mineralogical features affect both sintering kinetics and pyroplasticity, which depends on both the melt viscosity and the amount of crystals suspended in the liquid phase. In fact, firing deformation could scale with crystals shape and size distribution, which in turn reflect in a complex way the dissolution rate of mullite and quartz into the melt (buffered by silica oversaturation and strong peraluminous character).