Dissolution mechanisms of minerals in silicate liquids of industrial interest

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Abstract

Despite the advancements made by glass makers, unmolten grains are still a significant issue in this industry. These defects are mainly due to the incomplete dissolution of more refractory phases from the batch or the furnace lining material. Even though few studies are available in the literature, there are significant differences among reported dissolution rates, proposed mechanisms, and industrial observation. Therefore, a comprehension of the relevant parameters is crucial to better understanding the appearance of such defects.

With the ultimate goal of developing a more reliable model to address the generation of unmolten grains in an industrial soda-lime-silica glass, the first set of alumina dissolution experiments was conducted at high temperatures, focusing on the rate-limiting mechanism identification under static conditions. Particular attention is paid to the quantification of the composition of the liquid present at the mineral interface, its structural characterization, and the diffusion of chemical elements in the liquid away from the grain. These observations are then compared with interface-controlled and diffusion-controlled dissolution theories.
These preliminary results reveal that the diffusion behavior of one element is strongly coupled with that of the other components, consistent with multi-component diffusion theory. This phenomenon has consequences for the evolution of the interface composition, its microstructure, and the onset of natural convection with time. Therefore, identification of the details of diffusion behaviour is an essential step toward obtaining new and robust dissolution models.

Keywords: dissolution, alumina, digestion, diffusion, soda, lime silica glass

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