Glass synthesis: Focus on Industrial and nuclear glasses

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Abstract

Understanding of the reaction steps that occur during glass production is crucial for the optimization of the melting process and to avoid the presence of heterogeneities in the produced glasses (bubbles, undissolved grains, crystals, separated phases). In this presentation, we will describe the physico-chemical mechanisms that lead to the formation of a homogeneous liquid in industrial glass melting furnaces (float glass in particular) and in nuclear waste conditioning processes (French and American cases). We begin by describing the reaction mechanisms involved in the production of French and American nuclear glass. We will then focus on the phenomena implied in the production of a soda-lime-silica glass made from silica and sodium and calcium carbonates. We will show what reaction paths are possible to achieve the desired liquid composition, and why it is crucial to control the properties of the precursors used (particle size, microstructure, melting and decomposition temperatures) to obtain a homogeneous liquid. These explanations will be based both on knowledge of phase diagrams and on in situ analyses at temperature, enabling us to characterize changes in compositions and morphologies (tomography, environmental SEM) and thermal effects (ATD/ATG) associated with melting and decomposition reactions. Finally, we will discuss the contribution of physico-chemical modeling to optimizing the glassmaking process.

Keywords: Glass melting, industrial glass, nuclear glass

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