Crystal growth in temperature gradients

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Abstract

The vitrification of nuclear waste by the cold crucible inductive melter (CCIM) started at La Hague plant in 2010. With this type of melter, the glass melt is heated by direct induction, while the edges of the crucible are cooled by a water circulation system. As a result, in the neighbour of the cooled edges, the glass melt is exposed to a strong temperature gradient (of the order of 1000∘C.cm-1), going from its liquid state (in the glass melt at 1200∘C) to its solid state (near the edge). During the vitrification process, this "frozen" glass layer, called the skull-melter, will be exposed to this temperature gradient for several weeks, what can potentially lead to a partial crystallization. The aim of this work is to determine the impact of this temperature gradient configuration on crystallization properties, as such configuration is known to sometimes lead to an oriented growth of crystals [1, 2].
In a first step, the crystallization properties of a simulated simplified nuclear glass have been studied in isothermal conditions and kinetics growth have been determined, mainly by SEM and XRD analysis. In a second step, a specific equipment has been built to reproduce the skull-melter conditions at laboratory scale, and a 11-weeks experiment has been conducted. The comparison of isothermal and thermal gradient experiments allows to discuss the impact of the temperature gradient conditions on crystallization mechanisms and kinetics.

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