Internal Nucleation of Glass

ROLE OF THE PLATINUM METALS IN CONTROLLED CRYSTALLISATION

Glass normally devitrifies by the growth of crystals nucleated either at the surface or at some internal imperfections such as inclusions or bubbles. The crystals so formed are coarse and possess a distinct orientation which results in a marked deterioration of mechanical and physical properties.

Recent work has shown that crystallisation of certain glasses can be closely controlled to produce a fine, uniform grain size and a completely random orientation. The resulting materials, known as "glass-ceramics", possess remarkably enhanced mechanical and electrical properties when compared to the normal glasses of the same chemical composition and their development has opened up an interesting new field. This interest was acknowledged by the American Ceramic Society during its April meeting in Toronto, when a symposium was held on "Nucleation and Crystallisation".

To obtain the fine grain structure it is necessary to have present in the glass a large number of nuclei around which crystal growth can develop. The first glasses examined were those containing titania. It was found that after suitable heat treatment a dispersed precipitate of a titania-rich phase was formed which then acted as nuclei for subsequent crystal growth.

Several papers at the symposium dealt with the formation of these nuclei, but it is apparent that many problems remain unsolved.

Other glasses containing small amounts of copper, gold, silver or cerium were found to be photosensitive, nuclei being formed by subjecting the glasses to ultra-violet radiation. Heat treatment then produced the fine crystal growth.

It had also been shown by G. E. Rindone, of the Pennsylvania State University, that glasses containing neither titania nor photosensitive elements can be effectively nucleated by any member of the platinum group of metals. Examples are alkaline phosphate and silicate glasses which are aided to form fine crystals by the presence of collodial platinum liberated from platinum chloride added to the melt.

No special heat treatment is required to develop these nuclei since the suspension forms during melting. Crystal growth occurs when the glass is reheated to about 600°C.

In a paper given in Toronto on "Crystal Orientation as Influenced by Platinum Nucleation" Rindone described the effect of platinum nucleation on the orientation of lithium disilicate crystals formed from lithium silicate glasses. The normal devitrification process of this glass produces crystals with a marked orientation relative to the surface. When the glass is inoculated with platinum during melting this tendency towards orientation in the surface layers is greatly decreased and is completely eliminated a few microns below the surface.

Patents recently granted to Corning Glass Works in the name of S. D. Stookey, the pioneer of this type of glass-ceramic material, describe the inoculation with platinum group metals of a number of types of glass. The inoculant is added to the melt as a compound which on dissociation gives a free metal content of between 0.001 and 0.01 per cent in the glass. The desired fine crystal size along with improvements in properties are then attained by heat treating in the range 580° to 650°C.

It is evident that platinum group metal inoculants can be used in a wide variety of glasses because of their ability to form an insoluble colloidal suspension capable of acting as crystal nuclei.

J. A. S.