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An invited talk

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Self-limited growth of nanocrystals in structural heterogeneous phosphosilicate melts during cooling

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Abstract: Highly transparent bulk glass-ceramics were obtained by the melt–cooling–devitrification (MCD) approach in a phosphosilicate glass system. Crystals spontaneously form in glass melts during cooling from certain temperatures above liquidus points. The structural heterogeneity plays a key role in fast crystallization initiated by heterogeneous nucleation. The spontaneous nanophase-separation is the main reason of the structural heterogeneity, and hence, of the heterogeneous nucleation. Furthermore, the separated phosphate-rich glassy phase can serve as the floppy region both for forming sodium phosphate crystals upon cooling, but also for limiting the overgrowth of sodium phosphate nanocrystals since the matrix silicate-rich glassy phase are highly viscous, i.e., the ionic diffusion is rather slow. Therefore, substitution of B_2O_3 or Al_2O_3 for partial Na_2O accelerates the spontaneous crystallization of sodium phosphate nanocrystals due to the enhanced phase-separation degree, even though the viscosity of matrix silicate-rich phase is increased. This is confirmed by the fact that substitution of B_2O_3 or Al_2O_3 for Na_2O lowers the activation energy for non-isothermal crystallization and increases the critical cooling rates for glass formation.

Keywords: Structural Heterogeneity, Phase Separation, Crystallization, Self-limited Crystal Growth

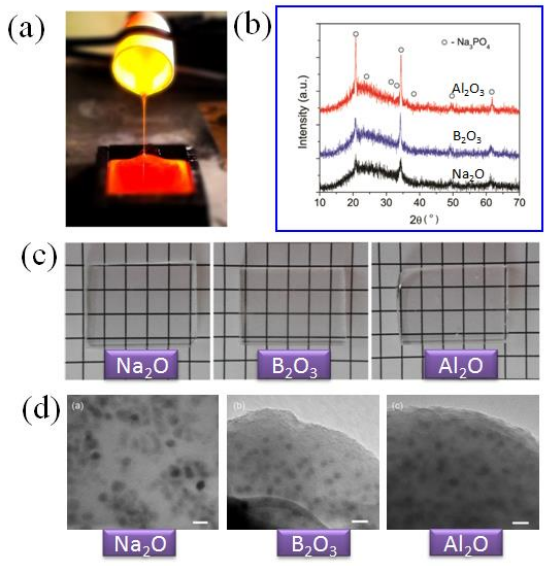

Figure 1 Glass-ceramics obtained melt-cooling-crystallization method. (a) Melt casting during which nanocrystals spontaneously form; (b) XRD patterns of the as-produced bulk samples; (c) Appearance of three glass samples containing Na_2O, Na_2O+B_2O_3 and Na_2O +Al_2O_3, respectively; (c) TEM photographs of the samples.

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