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An invited talk

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

Shujiang Liu^{1*}, Haizheng Tao², Yanfei Zhang³, Yuanzheng Yue^{1,2,3}

¹School of Materials Science and Engineering, Qilu University of Technology, Jinan 250353, China.

²State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, China

³Department of Chemistry and Bioscience, Aalborg University, 9220 Aalborg, Denmark

*Corresponding author: lsj-24@163.com

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 B₂O₃ or Al₂O₃ for partial Na₂O 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 B₂O₃ or Al₂O₃ for Na₂O 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

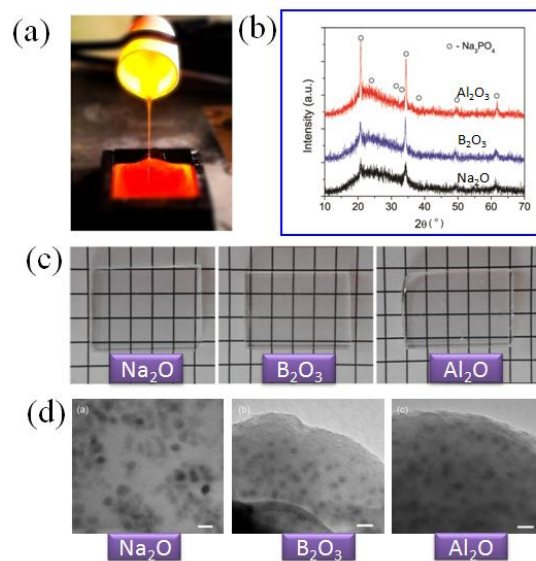


Figure 1 Glass-ceramics obtained melt-cooling-crystallization method. (a) Melt casting during which nanocrystals spontaneously form; (b) XRD patterns of the as-produced bulk samples; (c) Appearance of three glass samples containing Na₂O, Na₂O+B₂O₃ and Na₂O +Al₂O₃, respectively; (d) TEM photographs of the samples.

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