The Effect of Alkaline Earths on Fictive-Temperature Dependent Glass Properties

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Abstract

Glass structure and properties vary as a function of thermal history, a phenomenon that is recorded by a parameter called fictive temperature. The fictive temperature of a glass changes such that the faster the cooling rate the glass experiences during quenching, the higher the fictive temperature. By varying fictive temperature, the glass structure and properties can be changed considerably. The extent to which these changes occur (i.e. the thermal history sensitivity of the glass) is determined by the bulk composition.
In this study, simple ternary and quaternary systems are used to investigate the compositional effect of alkaline earth (AE) modifiers on fictive-temperature dependent glass properties such as Young's modulus, refractive index, and density. The model system is comprised of 74 mol% SiO2, 16 mol% Al2O3, 10 mol% RO, where RO content is the sum of one or more of the following: MgO, CaO, SrO, and BaO. Preliminary results show that the properties of glasses with lower field strength AEs experience smaller changes as a function of fictive temperature than glasses with higher field strength AEs. We show that this reduction in the changes to thermal history sensitive glass properties is due to a more loosely-packed glass structure in the case of lower field strength-containing glasses. Single versus mixed AE effects are also investigated. By understanding the effect of AE modifiers on the thermal history sensitivity of simple systems, we hope to gain insight into the effect of AEs on the thermal history sensitive properties of more complex systems.

Keywords: Alkaline Earth, Fictive Temperature, Young's Modulus

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