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Smedskjær, Morten Mattrup; Mauro, John C.; Deubener, Joachim; Yue, Yuanzheng

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Diffusion of Alkali and Alkaline Earth Ions in Silicate Glasses and its Correlation with Liquid Fragility

Morten M. Smedskjaer,^{a,*} John C. Mauro,^b Joachim Deubener,^c and Yuanzheng Yue^a

^a *Section of Chemistry, Aalborg University, DK-9000 Aalborg, Denmark*

^b *Science and Technology Division, Corning Incorporated, Corning, NY 14831, USA*

^c *Institute of Non-Metallic Materials, Clausthal University of Technology, D-38678 Clausthal-Zellerfeld, Germany*

* Corresponding author. Tel.: +45 99407240. E-mail address: morten04@bio.aau.dk

A physical understanding of diffusion processes in glasses is of great scientific and technological importance. In this work, we study the influence of the type of alkali and alkaline earth ions on the ionic diffusivity and fragility of iron-bearing silicate glasses. The modifying-ionic inward diffusion occurs in the glasses when Fe^{3+} is reduced to Fe^{2+} . In the $\text{SiO}_2\text{-Na}_2\text{O-Fe}_2\text{O}_3\text{-RO}$ ($\text{R} = \text{Mg, Ca, Sr, Ba}$) glass series, the extent of diffusion decreases in the sequence Mg^{2+} , Ca^{2+} , Sr^{2+} and Ba^{2+} . In the $\text{SiO}_2\text{-A}_2\text{O-Fe}_2\text{O}_3\text{-CaO}$ ($\text{A} = \text{Na, K, Rb, or Cs}$) glass series, the Ca^{2+} ions diffuse faster than alkali ions and the activation energy of the Ca^{2+} diffusion decreases with alkali size. In both series, the inward diffusion increases with a decrease in the fragility (m) of the glass systems. In this work, we have discussed the origin of this relation. In addition, we have proposed a simple model to explain the correlation between m and T_g of the glasses.