Structure, Ionic Mobility, and Mechanical Stiffness in Mixed-Network Former Glasses

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Abstract

We investigated the adiabatic elastic properties and ionic conductivities of two series of mixed network former glasses, sodium borosilicates and sodium borogermanates using Brillouin light scattering (BLS) and dielectric impedance spectroscopy, respectively. Using data from NMR spectroscopy and BLS as input for a reaction equilibrium-based statistical thermodynamic model we constructed a detailed structural model of these glasses. This model yields statistical measures for the distribution of cation hopping pathways in these glasses. Our analysis reveals strong correlations between elastic and transport properties, which allow us to develop a more detailed formulation of transition state theory describing the modifier cation migration in these materials. We find that the structural deformation during a cation jump is almost entirely controlled by the bulk modulus. Our analysis allows us to assess the spatial extent of this deformation, as well as estimate the relative amounts of configurational and vibrational entropy changes associated with this thermally activated process. Funding: NSF-DMR_1610742

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