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NETWORK TOPOLOGY AND DIFFUSION IN SODA LIME BORATE GLASS SYSTEMS

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In this paper, we have investigated the structure, transport properties, and network topology of the borate glass series (in mol%): $(89-x)\text{B}_2\text{O}_3 - x\text{Na}_2\text{O} - 10\text{CaO} - 1\text{Fe}_2\text{O}_3$ with $x = 5, 10, 15, 20, 25, 30$, and 35 . By using a temperature-dependent topological constraint model, we have predicted the scaling of the glass transition temperature, fragility, and boron speciation with composition (x). Experimental results are in good agreement with the predicted ones, and this provides insights into the correlation between the glassy dynamics and the structure of soda lime borate glasses. Through this correlation, we attempt to clarify the origin of the correlation between the inward cationic diffusion and the glass composition. The inward cationic diffusion is induced by reducing ferric ions to ferrous ions in the glasses near the glass transition temperature. The extent of inward diffusion varies with composition and this variation depends on the boron speciation and the electrostatic environments of the involved modifying ions. This work also provides information on the microstructural origin of fragility of oxide liquids.

Keywords: Borate glasses; diffusion; network topology; topological constraint model; boron speciation; fragility; glass transition