Network Topology and Diffusion in Soda Lime Borate Glass Systems

Smedskjær, Morten Mattrup; Mauro, John C.; Sen, Sabyasachi; Yue, Yuanzheng

Publication date:
2010

Document Version
Early version, also known as pre-print

INTERNATIONAL CONGRESS ON GLASS
BAHIA - BRAZIL
ICG2010
GLASS • ENVIRONMENT AND SUSTAINABILITY
September 20 to 25 - 2010

NETWORK TOPOLOGY AND DIFFUSION IN SODA LIME BORATE GLASS SYSTEMS

Morten M. Smedskjaer[1]*, John C. Mauro[2], Sabyasachi Sen[3], Yuanzheng Yue[1]

[1] Section of Chemistry, Aalborg University, Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark – morten04@bio.aau.dk*
[2] Science and Technology Division, Corning Incorporated, Corning, NY 14831, USA
[3] Department of Chemical Engineering and Materials Science, University of California at Davis, Davis, CA 95616, USA

In this paper, we have investigated the structure, transport properties, and network topology of the borate glass series (in mol%): (89-x)B_2O_3 – $x$$Na_2O$ – 10CaO – 1Fe_2O_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*