Sodium diffusion in boroaluminosilicate glasses

Understanding the fundamentals of alkali diffusion in boroaluminosilicate (BAS) glasses is of critical importance for advanced glass applications, e.g., the production of chemically strengthened glass covers for personal electronic devices. Here, we investigate the composition dependence of isothermal sodium diffusion in BAS glasses by ion exchange, inward diffusion, and tracer diffusion experiments. By varying the [SiO2]/[Al2O3] ratio of the glasses, different structural regimes of sodium behavior are accessed. We show that the mobility of the sodium ions decreases with increasing [SiO2]/[Al2O3] ratio, revealing that sodium is more mobile when it acts as a charge compensator to stabilize network formers than when it acts as a creator of non-bridging oxygens on tetrahedrally-coordinated silicon and trigonal boron. The impacts of both the addition of iron and its redox state on the sodium diffusivity are explored in terms of the structural role of ferric and ferrous ions. By comparing the results obtained by the three approaches, we observe that both the tracer Na diffusion and the Na-K interdiffusion are significantly faster than the Na inward diffusion. The origin of this discrepancy could be attributed to the fact that for sodium inward diffusion, the charge compensation for electron holes is a rather slow process that limits the rate of diffusion. (C) 2011 Elsevier B.V. All rights reserved.