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Anomalous elasticity in densified sodium germanate glasses

Søren S. Sørensen[1], Ying Shi[2], Lars R. Jensen[3], Michal Bockowski[4], Morten M. Smedskjaer[1]

[1]*Department of Chemistry and Bioscience, Aalborg University, Denmark*
[2]*Science & Technology, Corning Incorporated, Corning, NY 14831, USA*
[3]*Department of Materials and Production, Aalborg University, Denmark*
[4]*Institute of High-Pressure Physics, Polish Academy of Sciences, 01-142 Warsaw, Poland*

Germanate glasses are well-known for their anomalous coordination number changes upon addition of modifiers such as alkali and alkaline earth oxides. Similar to this phenomenon, network formers such as boron and aluminum also feature permanent changes in their coordination numbers under an applied pressure, even at moderate pressures (≤2 GPa) upon combined high-temperature/high-pressure treatment (so-called hot compression). In this work, we have performed hot compression at 0.5, 1.0, and 2.0 GPa of two sodium germanate glasses ($10Na_2O$-$90GeO_2$ and $20Na_2O$-$80GeO_2$). Young's and bulk moduli as well as the Vickers hardness all increase with the applied pressure, whereas the shear modulus for both glass compositions features a pronounced maximum at 1.0 GPa of applied pressure. Consequently, Poisson's ratio increases by 10-20% upon hot compression at 2 GPa compared to the as-prepared glass. To identify the structural origin of anomalous elasticity behavior, we performed X-ray and neutron total scattering as well as *ab initio* molecular dynamics simulations. We mainly observe structural changes at the medium-range order length scale. Our results may thus aid in understanding the structural features governing the mechanical properties of network glasses with several coordination states.