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Januchta, Kacper; Sun, Ruofu; Huang, Liping; Smedskjær, Morten Mattrup

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Characterization of deformation and cracking behavior of high Poisson's ratio oxide glasses with La₂O₃

Kacper Januchta ^{*† 1}, Ruofu Sun ², Liping Huang ², Morten Smedskjaer ¹

¹ Department of Chemistry and Biosciences, Aalborg University – Aalborg, Denmark

² Dept. Materials Science and Engineering, Rensselaer Polytechnic Institute – Troy, New York 12180, United States

Poisson's ratio (ν) is the negative of the ratio of the transverse strain to the longitudinal strain for a uniaxial stress state. The adjustment of ν is receiving increasing interest as a means of tailoring the ductility of glasses. This has been motivated by the observation of intrinsic ductility in high- ν (above 0.32) bulk metallic glasses, but it is unknown whether the same relation between ductility and ν exists in oxide glasses since all known oxide compositions exhibit ν -values below or around 0.32. In this study, we attempt to manufacture high- ν oxide glasses using two approaches both based on La₂O₃ incorporation: (i) Known high- ν glass compositions (La₂O₃-containing aluminoborate, aluminogermanate, and aluminosilicate) are first synthesized, and then subjected to hot compression treatment to further increase their atomic packing density and thus likely high ν . (ii) ZnO-B₂O₃ glass composition is doped with increasing amounts of La₂O₃ to increase ν . These glass systems are investigated using various characterization techniques to understand the mechanical response of high- ν oxide glasses. Elastic moduli including ν -values are determined through Brillouin light scattering and ultrasonic echography techniques. Hardness, crack resistance, and cracking patterns of all glasses are investigated using Vicker's microindentation. For selected compositions, annealing-induced volume recovery of indentation imprints is studied to shed light on the deformation mechanisms controlling the response of glass to sharp-contact loading. Finally, micro-Raman spectroscopy is used to acquire Raman spectra in the as-made and the hot compressed glasses, as well as inside the Vicker's indentation imprints of the as-made glasses. The deformation and cracking characteristics are linked with structural features of the investigated glass compositions.

Keywords: indentation, poisson's ratio, cracking, deformation

*Speaker

†Corresponding author: kja@bio.aau.dk