A structural approach towards the design of a hard and crack-resistant Al2O3–rich glass

Rebecca, Anne; Kapoor, Saurabh; Januchta, Kacper; Youngman, Randall E.; Huang, Liping; Smedskjær, Morten Mattrup; Goel, Ashutosh

Publication date:
2018

(GOMD-S1-037-2018) A structural approach towards the design of a hard and crack-resistant Al_2O_3–rich glass

A. Rebecca[*1]; S. Kapoor[1]; K. Januchta[2]; R. Youngman[3]; L. Huang[4]; M. M. Smedskjaer[2]; A. Goel[1]

1. Rutgers University, Materials Science and Engineering, USA 2. Aalborg University, Department of Chemistry and Bioscience, Denmark 3. Corning Incorporated, Science and Technology Division, USA 4. Rensselaer Polytechnic Institute, Materials Science and Engineering, USA

Designing new glasses with excellent ability to resist stress-induced crack initiation and growth is of utmost importance for advanced glass applications. Al_2O_3-rich glasses have been shown to possess both high hardness (HV) and crack resistance (CR). However, their limited glass forming ability and extremely high processing temperatures (>1800°C) constrains them to the realms of academic research. In this study, we report on the structural design of a hard (HV > 7 GPa at 200 gf Vickers load), crack-resistant glass with Al_2O_3 > 30 mol.%. The as-designed glass can be synthesized by conventional melt-quench technique at temperature ≤ 1675°C and can be produced in any desired shape and size. The Vickers' hardness of the annealed glass was measured to be ≥7 GPa at 200 gf, while no cracks were observed up to 2 kgf load under ambient conditions. The MAS-NMR spectroscopy adjoined with atomic force microscopy (AFM) and simulated nano-indentation studies have been employed to understand the structural origin of the elastic and mechanical properties of this glass.