Observation of Crack-Free Vickers Indents at 500 N in Annealed Caesium Aluminoborate Glass

Januchta, Kacper; Stepniewska, Malwina; Yue, Yuanzheng; Jensen, Lars Rosgaard; Zhang, Yang; Munch, Steffen S.; Somers, Marcel A. J.; Smedskjær, Morten Mattrup

Publication date:
2019

Observation of Crack-Free Vickers Indents at 500 N in Annealed Caesium Aluminoborate Glass

K. Januchta*[1] ; M. Stepniewska[1] ; Y. Yue[1] ; L. Jensen[2] ; Y. Zhang[3] ; S. Munch[3] ; M. Somers[3] ; M. M. Smedskjaer[1]

1. Aalborg University, Department of Chemistry and Bioscience, Denmark 2. Aalborg University, Department of Materials and Production, Denmark 3. Technical University of Denmark, Department of Mechanical Engineering, Denmark

Crack-resistant oxide glasses are increasingly important in modern day society due to the demand for materials that exhibit excellent mechanical performance, yet maintain transparency and acceptable chemical durability. This is currently achieved through post-processing, but such processes could cause undesirable side effects and/or additional cost. There is thus an interest in improving glass mechanics through composition optimization. In the search for crack-resistant glasses, i.e., glasses requiring high loads to initiate cracking during sharp contact loading, we have recently focused on aluminoborate glass compositions. Although this glass system suffers from poorer chemical durability and lower hardness compared to the industrially favored silicate-based compositions, their resistance to crack initiation is superior to that of the latter family. In this work, we present a caesium aluminoborate glass, which can withstand loads as high as ~500 N during Vickers indentation without forming any radial cracks. This exceeds the highest crack resistance previously reported for untreated, annealed oxide glasses by one order of magnitude. In addition, the created indents exhibit a time-dependent shrinkage, analogous to self-healing, which has never been reported to our knowledge. We discuss the origin of these observed behaviors in terms of a proposed molecular-scale deformation mechanism.