Adaptive and Crack Resistant Aluminoborate Glasses

Invited Talk

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Publication date:
2018

(GOMD-S1-036-2018) Adaptive and Crack Resistant Aluminoborate Glasses (Invited)

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The inherent brittleness and poor crack resistance of oxide glasses are among their main limitations for enabling future applications. Impact or scratch events can lead to formation of cracks that amplify local tensile stresses, resulting in catastrophic failures. Therefore, increasing the hardness and crack resistance of glasses is critical for the development of damage resistant and mechanically durable glasses. We have recently discovered that alkali aluminoborate glasses exhibit a superior resistance to sharp contact-induced cracking compared to most oxide glasses. The high crack resistance is associated with the ability of the glasses to self-adapt the connectivity of their network under compressive stress, which facilitates densification and thus aids in dissipation of the energy supplied during impact. Here, based on series of aluminoborate glasses comprising various alkali and alkaline earth oxide modifiers, we discuss the dependence of the glasses' structural and mechanical properties on the field strength (ratio of charge to size) of the modifiers. We show that the stiffness, hardness, deformation mechanism, and toughness depend on a fine balance between the atomic bonding energy, the packing efficiency of the atoms, and the ability of the network to densify reversibly or irreversibly, with each of these features showing a different dependence on the modifier field strength.