

Stress corrosion cracking of sodium borosilicate amorphous phase separated glasses

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Oxide glasses are widely used in daily life. Yet, they have a major drawback: they seem to fail abruptly. A small defect or flaw existing inside the glasses under stress may lead to the failure of the material. This process is called sub-critical crack growth, also called stress corrosion cracking (SCC), which is aided by environmental factors (humidity, temperature, etc.).

Sodium borosilicate (SBN) glasses concern an important research topic as the three components (SiO_2 , Na_2O , and B_2O_3) corresponding to the three principal oxides of many industrial glasses. Amorphous phase separation (APS) is a dominant feature for this system, which has industrial relevance for crush resistant glasses, porous glasses and glass ceramics. Moreover, theory, simulations, and experiments evidenced two-phase APS glasses; however, there is the possibility of three-phase APS for some compositions. APS inside the glasses induces complex heterogeneous structures at the nano-scale, which alters the glasses' physical and mechanical/fracture properties. However, the connection between the structure of APS glasses and their properties remains poorly understood, especially the SCC behavior.

In order to study the effects of APS structure on glass SCC behavior, we focus on a SBN glass system with compositions falling in the hypothesized three-phase APS zone. Atomic Force Microscopy (AFM) aids in illustrating the growth of the APS morphology in the annealed samples. Additionally, NMR spectrums help in understanding the short-range structure of the APS glasses. SCC tests were performed via Deben machine and Double Cleavage Drilled Compression (DCDC) samples. Along with post-mortem studies of fracture surfaces, we aim at understanding the failure mechanisms in the APS glasses. These results will be discussed during the presentation. This study will aid in capturing holistic viewpoint of how glasses fail.