How do we access the liquid fragility more easily and accurately?

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Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

How do we access the liquid fragility more easily and accurately?

Qiuju Zheng[a, c], John C. Mauro [a, b], Yuanzheng Yue[a, c]

[a]*School of Materials Science and Engineering, Qilu University of Technology, 250353 Jinan, China*

[b]*Science and Technology Division, Corning Incorporated, Corning, NY 14831, USA*

[c]*Department of Chemistry and Bioscience, Aalborg University, DK-9000 Aalborg, Denmark*

qlzhengqj@163.com, oral presentation

Abstract: The liquid fragility index (m_{vis}) describes the rate of viscosity change of a glass-forming liquid with temperature at the glass transition temperature (T_g), which is very important for understanding liquid dynamics and the glass transition itself. According to the definition of fragility, it should be directly determined using viscosity measurements. However, viscosity measurements are difficult for some glass-forming systems, especially those systems with strong crystallization tendency and high liquidus temperatures. Therefore, alternative methods are needed to give an indirect quantification of fragility. It is known that one simple method is based on measurement of the calorimetric fragility index (m_{DSC}), i.e., the changing rate of fictive temperature (T_f) with heating (cooling) rate in a small T_f range around T_g. However, we have found a systematic deviation between the calorimetric and kinetic fragilities for the glass compositions that we have collected so far. The kinetic fragility is generally measured to be higher than the corresponding calorimetric fragility, and larger deviation is associated with more fragile glass compositions. The deviation is attributed to the Arrhenian approximation of the $\log(1/q_c) \sim T_g/T_f$ relationship in the glass transition range. We have developed an empirical model to predict kinetic fragility (m_{vis}) using calorimetric fragility (m_{DSC}) across a wide range of fragilities [1]. The predicted fragility values agree well with the experimental fragility. By combining the universal high-T viscosity limit ($10^{-2.93}$ Pa·s) [2] with the MYEGA equation [3], the entire viscosity curve of oxide glasses can be well predicted just using DSC measurements without performing viscosity measurements. We will also discuss the link between liquid fragility and mechanical properties.

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