Glass Transition: Insights from Calorimetric and Structural Analysis

A keynote talk

Yue, Yuanzheng

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Yuanzheng Yue
Department of Chemistry and Bioscience, Aalborg University, 9220 Aalborg, Denmark
Email: yy@bio.aau.dk

Abstract: The glass transition stands out as one of the most crucial and intricate phenomena in the field of condensed matter science [1-4]. While substantial progress has been made in comprehending this phenomenon, several critical puzzles remain unresolved. I have two questions regarding the glass transition to propose: 1) Why does the temperature-dependent viscosity of glass not display a sudden and discontinuous change during the transition? 2) Which specific structural factor governs the process of glass transition? In this presentation, I aim to offer potential insights that could contribute to addressing these two questions. I will draw upon existing literature data as well as our own calorimetric and structural findings [5-11]. The interrelations among sub-T_g glass relaxation, glass rejuvenation, and the glass transition are discussed. Furthermore, the extent of the jump in isobaric heat capacity (C_p) during the glass-to-liquid transition (ΔC_p) was found to be closely correlated with the medium-range structure of glasses, which depends upon their chemical composition [8]. From this correlation, one can uncover the underlying structural factors driving the glass transition phenomenon. Additionally, we found that C_p of oxide glasses at T_g obeys the Dulong-Petit law, i.e., it is three times the gas constant if its unit adopts "joules per mole of atoms" in glass [12]. In our explorations of the glass transition, we focus on four categories of glass-forming systems: oxides, chalcogenides, metals, and metal-organic frameworks. I describe the perspectives in glass transition studies, as well as the positive impacts of such studies on both the enhancement of glass properties and the optimization of the producing and testing conditions of glasses.

Key words: Glass Transition; Heat Capacity; Glass Structure; Viscosity

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