How much do we know about the fragility of glass-forming liquids? In honor of Austen Angell

An invited talk

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Publication date:
2022

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

How much do we know about the fragility of glass-forming liquids? In honor of Austen Angell

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The slow dynamics of glass-forming liquids is a complex but highly intriguing subject of the condensed matter science. It is also a critical factor that should be considered when designing new glass materials and in optimizing glass production process. It is generally accepted that Angell's liquid fragility concept is a key to understand the slow dynamics. The well-known log(viscosity)-T_g/T plot was obtained first in 1957 by Oldekop, and then in 1972 by Laughlin and Ulhmann. However, they did not interpret the physical meaning of this plot. In 1985, Angell proposed the liquid fragility concept to describe the dynamics of a significantly extended glass systems by the log(viscosity or relaxation time) versus T_g/T plot, i.e., the Angell plot [1]. He was the first who gave the term "liquid fragility", classified the glass-forming liquids into the "strong" and "fragile" categories, and quantified the liquid fragility. Through experiments and theoretical studies, he and his co-workers provided deep insight into physics of liquid fragility [2-3]. More importantly, his liquid fragility concept sparked great interest among physicists and glass scientists. Over the past 3 decades, substantial progress has been made in understanding the structural and thermodynamic origin of liquid fragility. In 1999, Angell et al published another seminal paper that reported on the fragile-to-strong (F-S) transition in water [4]. This made liquid fragility even more complex and fascinating [5]. It is indeed challenging to directly probe the structural, topological, and thermodynamic changes during this transition despite some recent interesting observations [6-10]. However, the microscopic theory describing the F-S transition has not been fully established. In this talk, I will describe the current understandings about both the liquid fragility and the F-S transition. I will point out the major challenges and perspectives in exploring the microscopic origin of the liquid fragility and in finding the connections between the F-S transition, liquid-liquid transition, and structural evolution.

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