Correlation between Kinetic and Structural Fragility in Metallic Liquids

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Fragility is a concept that is often correlated with glass formability. It is generally defined in terms of dynamical aspects of the liquid, usually based on the rate of increase of the viscosity as a function of the inverse temperature scaled to the glass transition temperature, T_g (i.e. T_g/T). Our experimental studies of the temperature dependence of the liquid structure factor, $S(q)$, for a range of metallic alloy liquids demonstrate a link between structural and kinetic fragility [1]. A scaling temperature, T_A, is also identified, which, based on the results of molecular dynamics simulations, corresponds to the onset of cooperative flow in the liquid [2]. Our recent experimental and MD results show that the rate of short-range and medium-range structural ordering in the liquid accelerates below the temperature of this dynamical crossover, further demonstrating the link between structure and dynamics. Further, for all metallic glass-forming liquids studied $T_g \cong T_A/2$, suggesting a deep connection between the onset of cooperative dynamics and the glass transition [3], which is supported by our recent MD results [4]. Finally, by scaling the inverse temperature by T_A, and the magnitude of the viscosity by the extrapolated viscosity at infinite temperature, η_o, a universal curve from T_A down to T_g is obtained for all of the metallic liquids studied. On average, η_o is equal to the product of the number density and Planck's constant [5]. These points will be discussed and suggestions made for further studies.

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