Thermodynamic Scaling in Ionic Liquids and Ionically Conducting Glasses with Network Formers

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Relaxation and diffusion in liquids and supercooled liquids obey general thermodynamic scaling [1]. In other words, $D$ (or $D/T$), $\tau$, $\tau_\alpha$ (and some other physical quantity) are functions of the product variable, $TV$ ($V$ is the specific volume and $T$ the temperature). Molecular dynamics (MD) simulations have been performed to study the scaling in an ionic liquid (1-ethyl-3-methylimidazolium nitrate) over wide temperatures and pressures ranges [2]. Behaviors of diffusivities are well described by master curves with $\gamma=4.0$ and 3.8 for cation and anion, respectively. Thermodynamic scaling in the lithium silicate glasses and melts was also examined. All diffusion coefficients of ions in lithium silicates of different compositions, and at various temperatures and pressures are successfully represented by a single master curve, with an assistance of the concept of the percolation of ion channels. The master curve enables us to predict the diffusivity under various thermodynamic conditions and different substructures, i.e. the ion channels. In both systems, the scaling is explained by the existence of common effective potentials related to the pair correlation functions.