



Liquid Structure and Phase Transitions

Our recent high-energy X-ray diffraction data from electrostatically-levitated transition metal liquids demonstrate the frequent development of icosahedral short-range order (ISRO) with supercooling. This ordering makes it difficult to nucleate the stable crystal phases, in one case leading to the formation of a metastable icosahedral quasicrystal phase. Those studies confirm a half-century-old hypothesis relating the structure of the liquid to the nucleation barrier and blur the distinction between homogeneous and heterogeneous nucleation. Quantitative measurements of the time-dependent nucleation rate in the glass and structural studies of the supercooled liquid demonstrate that for Zr-59Ti3Cu20Ni8Al10 the ISRO increases on supercooling into the glass, supporting a frustration model of the glass transition in that system. Measurements of the density and surface tension hint at liquid/liquid phase transitions in some liquids, which are associated with the developing ISRO. In one case they correlate with a proposed strong-to-fragile transition. The implications of these and other coupled processes on phase formation, stability and crystallization are discussed.

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