Excess light scattering in glass formers with a liquid-liquid phase transition

Mika Kobayashi and Hajime Tanaka
Institute of Industrial Science, University of Tokyo, Tokyo 153-8505, JAPAN.

Several glass-forming liquids are known to exhibit excess light scattering due to the long-range density fluctuations which can exceed 100 nm [1]. These fluctuations are known as "Fischer clusters" which can not be understood by considering density fluctuations only.

Triphenyl phosphite (TPP) is known to show a liquid-liquid phase transition and it can be explained by the existence of a second order parameter coupled to the density [2, 3]. To investigate the relationship between Fischer clusters and the liquid-liquid phase transition, we have carried out dynamic and static light scattering measurements on TPP.

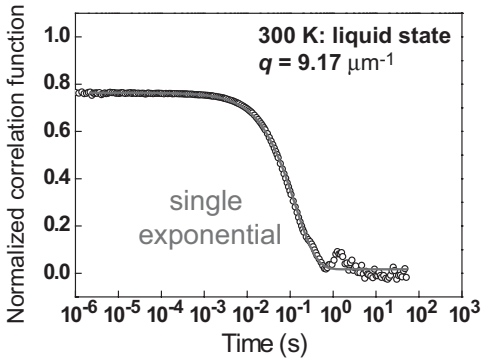

Figure 1: Ultra-slow mode of TPP obtained by dynamic light scattering at wavenumber q=9.17μm^{-1}.

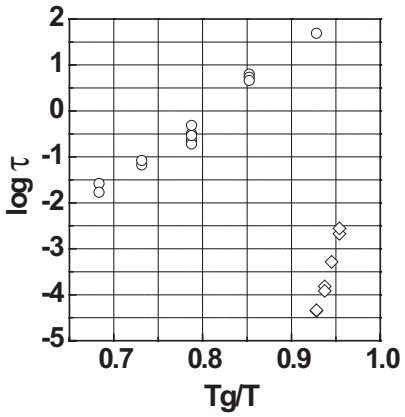

Figure 2: Relaxation time of ultra-slow mode (○) at q=25.1μm^{-1} and structural relaxation (◇) for TPP.

We found that TPP shows properties common to Fischer clusters. Figure 1 shows that TPP has an ultra-slow mode in the liquid state. The time scale of the ultra-slow mode is much slower than that of the structural relaxation (Fig. 2). The relaxation time depends on q^2, which suggests the mode is diffusive.

Static light scattering intensity increases with a decrease in temperature in Fig. 3. The intensity at each temperature shows the Ornstein-Zernike-type q-dependence.

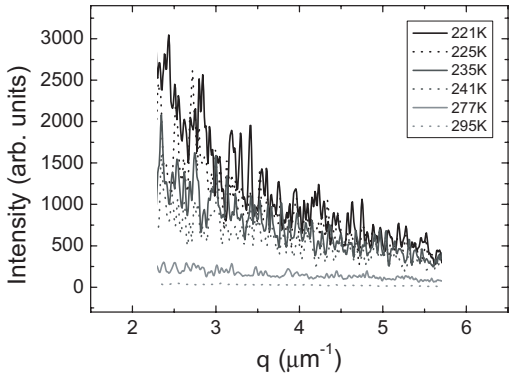

Figure 3: Static light scattering intensity for TPP at several temperatures. (melting point T_m=297 K, glass transition temperature T_g=205 K.)

Our preliminary results show that the correlation length obtained from the static light scattering increases near the spinodal temperature of the liquid-liquid phase transition. This suggests that Fischer clusters might reflect critical phenomena associated with the liquid-liquid phase transition.

References

[1] E.W. Fischer, Physica A **201**, 183 (1993).

[2] H. Tanaka, R. Kurita, and H. Mataki, Phys. Rev. Lett. **92**, 025701 (2004).

[3] H. Tanaka, Phys. Rev. E **62**, 6968 (2000).