Experimental report

09/02/2016

Proposal: **9-10-1403**

Council: 10/2014

Title: Probing single particle diffusion in the binary solvents close to itscritical poin

Research area: Soft condensed matter

This proposal is a new proposal

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Samples: silica
lutidine/water

Instrument	Requested days	Allocated days	From	To
IN15	12	9	21/11/2015	30/11/2015
D22	1	1	25/11/2015	26/11/2015

Abstract:

We propose to study the particle diffusion in a near-critical binary solvent with a focus to test the validity of the well-known Stokes-Einstein relationship. Both theories and our SANS measurements indicate that near a critical demixing temperature, an adsorbed layer can be formed on colloidal particle surface. For the much larger particles, it is well established that the Stokes-Einstein relationship should hold. However, it is unclear if this is true when the thickness of the adsorption layer, the correlation length of the solvent density fluctuation, and the particle diameters are comparable to each other. Therefore, we would like to directly measure the particle diffusion using neutron spin echo. By using contrast variation technique, the neutron scattering intensity from the solvent fluctuation can be completely suppressed so that NSE can reliably measure the particle diffusion to provide critical information to test the validity of the Stokes-Einstein relationship.

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The original experiment was supposed to follow dynamics of colloids in binary lutidine water solvent. We were not able to resolve the colloid dynamics in the dynamics window. Additionally the light scattering setup, which would have allowed us to calibrate the phase transition temperature, malfunctioned. As a backup plan we explored the phase diagram of the lutidine water system without colloids. We show the fitted diffusion constants of the critical 27% lutidine concentration binary solvent vs temperature. Interestingly the diffusion speeds up getting closer to the critical point for Q > 0.05 Å^{-1} while at Q < 0.05 Å^{-1}, the well-studied critical slowing down effect is observed. This enhanced dynamics at the large Q value (small length scale) cannot be explained by the temperature dependence of the viscosity changes. In addition, we notice that while the dynamics keep changing, the SANS patterns at the temperature higher than 20 C has little change for Q > 0.1Å^{-1}. This peculiar decoupling of the dynamic and structures may indicate a complex change of the solvent structure of the systems. And this type of structure change may be a general feature of all binary solvent systems that are used in many different types of applications.