15A/2001G082

SAXS measurement of supercritical xenon

Takeshi MORITA[1] and Keiko NISHIKAWA[2]
[1]Tokyo Univ. of Agriculture and Technology, Naka-tyo, Koganei, Tokyo 184-8588, Japan
[2]Chiba Univ., Yayoi, Inage-ku, Chiba 263-8588, Japan

Introduction

For disordered materials such as liquids, solutions, fluids and amorphous solids, concept of inhomogeneity is of peculiar importance. Small-angle scattering methods by use of x-ray and neutron give the most direct information on the inhomogeneity of molecular distribution. A supercritical fluid, which is defined as a fluid above its critical temperature and pressure, is essentially characterized by the large inhomogeneity. Because of much higher intensity of x-ray source than neutron one, a small-angle x-ray scattering (SAXS) method will be the most powerful and appreciable experiment for the study.

Recently we performed the SAXS study of supercritical fluids with hydrogen bonding such as water[1], methanol, ethanol, and alcohol aqueous solutions[2]. In this report, we describe the SAXS measurements for supercritical xenon, which contrastively is a simple fluid with only the van deer Waals interaction, to discuss the comparison of the behaviours of the inhomogeneity.

Experimental

At BL-15A, SAXS measurements for supercritical xenon were carried out along an isotherm at 302.0 K and pressures between 6.0 and 8.8 MPa. The corresponding density values are from 0.543 to 1.57 g/cm^3, ranging gaslike, intermediate, and liquidlike density regions. An x-ray beam was monochromatized to λ = 1.50 Å and the observable s-region was 0.01 Å^{-1} ~ 0.15 Å^{-1}, where the scattering parameter, s, is defined as $4\pi\sin\theta$ / λ (2θ : scattering angle, λ : wavelength).

Results and discussion

The SAXS intensities in typical thermodynamic states are shown in Fig. 1.

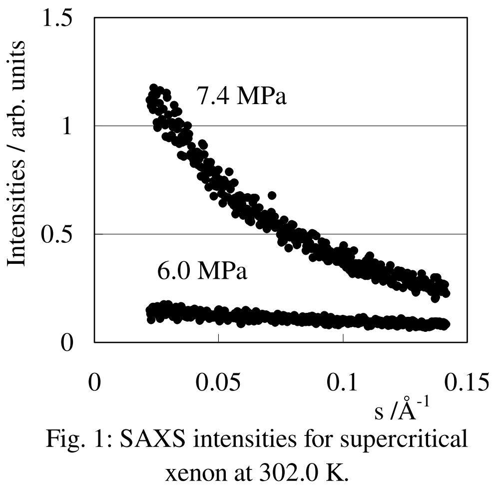

Fig. 1: SAXS intensities for supercritical xenon at 302.0 K.

Fig. 2 shows the Ornstein-Zernike plots for the same thermodynamic states as those shown in Fig. 1. The both plots show the satisfying linearity, though it is difficult to perform a SAXS measurement of supercritical xenon due to the large value of the absorption coefficient for xenon atom. The linearity indicates that little uncertainty was caused by the experimental and analytical procedure.

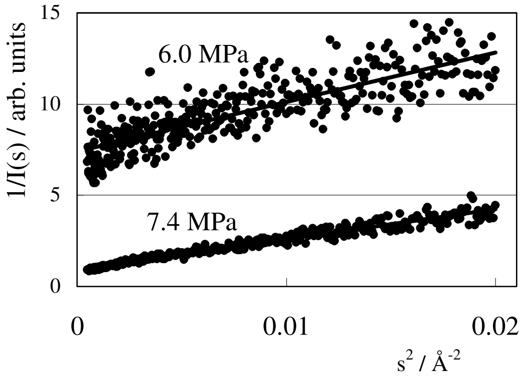

Fig. 2: The Ornstein-Zernike plots of supercritical xenon at 302.0 K.

The isothermal change of the density fluctuations of supercritical xenon at 302.0 K obtained by the SAXS intensities and the Ornstein-Zernike plots is shown in Fig. 3. The maximum value was estimated to be about 15 around at the critical density of xenon, 1.11 g/cm^3.

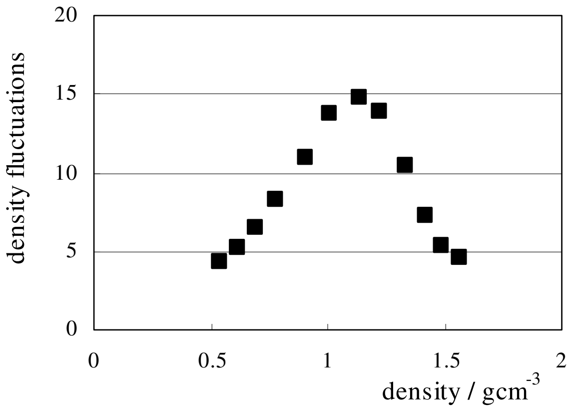

Fig. 3: Isothermal change of density fluctuations of supercritical xenon at 302.0 K.

References

[1] T. Morita et al., J. Chem. Phys., **112**, 4203 (2000).
[2] T. Morita et al., Rev. Sci. Instrum., **72**, 3013 (2001).

* tmori@cc.tuat.ac.jp