15A/2007G520

SAXS measurement of mixture of pentane-H_2O

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Introduction

It is one of the greatest mysterious things of science, where did organization emerge. Mixing scheme of hydrocarbon and water obeys an important rule in the quest. We note the spot of hot water jet on the seabed. In the spot, hydrocarbon dissolves into water, though they are not miscible under ambient condition.

Pentane (C_5H_{12}) also can't mix with water under ambient condition, however they can mix each other under high temperature and pressure generated nearby the spot. In this case, that keep mixing forcibly, mesoscopic structure has very interesting behavior. SAXS measurement is useful method to obtain information on the density-density correlation length ($G(r)$), that is the measure the inhomogeneity of molecular. We show that this result will relate to isothermal compressibility (κ_T).

Experimental

At BL-15A, SAXS intensities of the mixture were measured along an isotherm at 487.3K (T/T_c = 1.04) and pressures of 2-17 MPa. The concentration set at 0.225 in mole fraction of pentane at 4 MPa, and those of concentrations the other solutions was corresponding to saturated pentane with water. The holder is made of titanium, and the window material is diamond. Gold wire was used for gasket of the cell. All parts endure corrosion by the mixture. Air was leaved from each sample by supersonic wave.

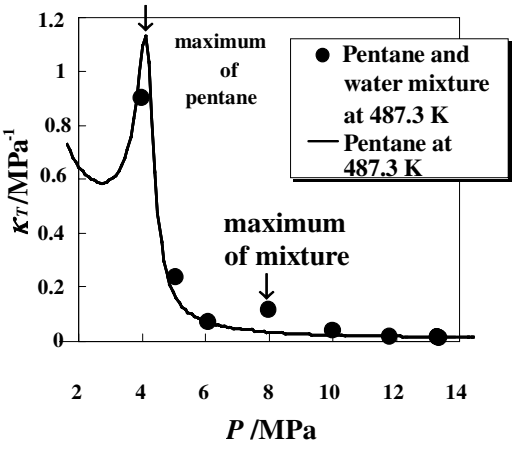

Fig. 1: Pressure dependence of isothermal compressibility for neat pentane and mixture.

Result and discussion

The isothermal compressibility, κ_T, was calculated by the value of density, which was measured by X-ray absorption. The isothermal compressibility is effective parameter of compressibility. The $G(r)$ is defined by the parameter how long the correlation of cluster is able to have in the fluid. As fluctuation becomes bigger, the value of $G(r)$ is bigger at long distance. In other words, in the case $G(r)$ sharply decreases with distance, main size of molecular cluster is smaller. In the other case $G(r)$ flatly decreases with distance, increase the rate of bigger cluster.

Figure 1 shows pressure dependence of isothermal compressibility for neat pentane and mixture. The maximum for mixture sifts to higher pressure than that for neat pentane. This indicates that the system becomes less compressible by mixing with water. Figure 2 shows $G(r)$ at the measured pressure. As shown in Fig. 2, correlation of the molecules grows in 4-5 MPa, and it becomes the weaker at 6 MPa. At 8 MPa, the increase is observed and then decrease with pressure. The result indicates that pentane and water will not mix enough each other on this state.

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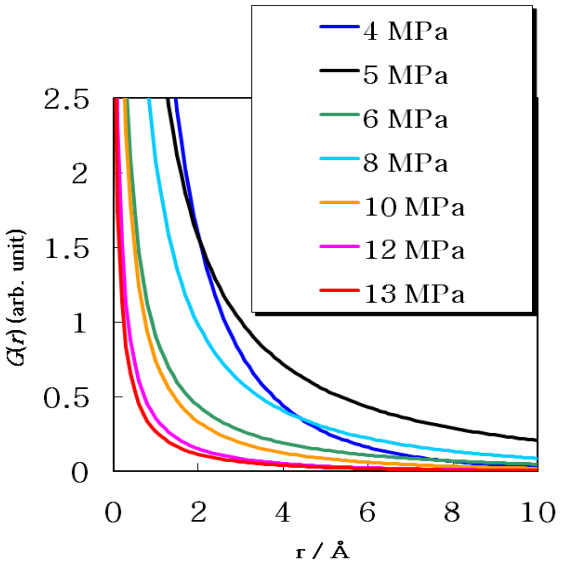

Fig. 2: $G(r)$ at the measured pressure.