Influence of supercritical carbon dioxide and organic solvents on the mobility of polystyrene

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Supercritical carbon dioxide (SC-CO2) has been used in a variety of industrial fields. For example, SC-CO2 is employed as a solvent in the extraction process of food industry because of its low toxicity and environmental impact. The high diffusibility and plasticizing effect are also utilized in polymer processing technologies.

In order to investigate the influence of supercritical carbon dioxide on polymeric materials, we have studied the dynamical properties of atactic polystyrene (aPS) in supercritical carbon dioxide by incoherent quasielastic neutron scattering (QNS), which has advantages suitable to monitoring the molecular motions of organic materials in SC-CO2; QNS can probe a sample in a thick pressure vessel and SC-CO2 practically has no contribution to QNS spectra.

Fig. 1 shows the temperature and CO2 pressure dependence of the mean square displacement <u2> of hydrogen atoms, which was obtained from Q-dependence of elastic scattering intensity. Here, <u2> is normalized with respect to the value at 320 K. The influence of SC-CO2 is clearly reflected in the value of <u2>. Under the condition of no CO2, <u2> remains almost constant until 380 K near the glass transition (Tg) of aPS, whereas it starts to increase at a lower temperature as the pressure of CO2 increases. This result indicates the plasticizing effect of CO2 gas on the molecular motions of aPS.

The present study has also shown that supercritical carbon dioxide plasticizes atactic polystyrene and activates both fast motions with characteristic time of about 7 ps and slow motions with characteristic time of about 110 ps. The formers are due to localized motions with a small activation energy and the latters are due to large scale motions of aPS chains activated around the glass transition point.

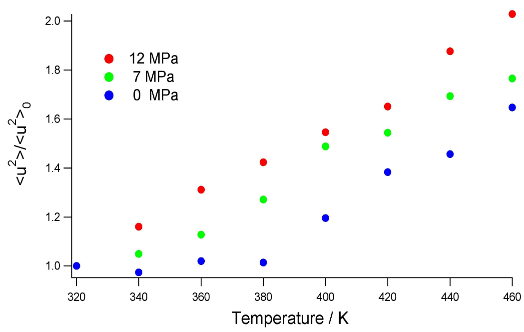

Fig. 1. Temperature and CO2 pressure dependences of the mean square displacement <u2> in aPS.