IV-L Development of Pulsed Field Gradient NMR Spectroscopy

Pulsed field gradient spin echo (PGSE) nuclear magnetic resonance (NMR) is a powerful method for the study of dynamics in condensed matter since it probes translational motion of molecules selectively, without being affected by vibrational or rotational motions. Due to this advantage it has been widely applied to the dynamics of molecules in liquids. However, applications of this technique to strongly dipole-coupled spin systems with short T_2 or to the study of slow and anisotropic self-diffusion are still challenging works because combined techniques of line-narrowing, pulsing of sharp and intense field gradients, and two-dimensional field-gradient generation are necessary.

In the present study we applied the technique to the study of self-diffusion in solid state, with the use of the laboratory-made spectrometer equipped with a rotatable quadrupole coil.

IV-L-1 Direct Measurement of Self-Diffusion Coefficients in Solids: Plastic Crystalline Hexamethylethane

OISHI, Osamu

Direct measurements of self-diffusion coefficients in solids were made possible without resorting to classical indirect methods such as line width or relaxation time measurements. This experiment was made possible with an automatic PGSE apparatus equipped with a quadrupole coil and a high power FG current driver. The diffusion coefficient D as small as 10^{-13} m^2s^{-1} was measured in the plastic crystalline phase of hexamethylethane (HME). The activation energy E_a was found to be 89 kJ mol^{-1}.

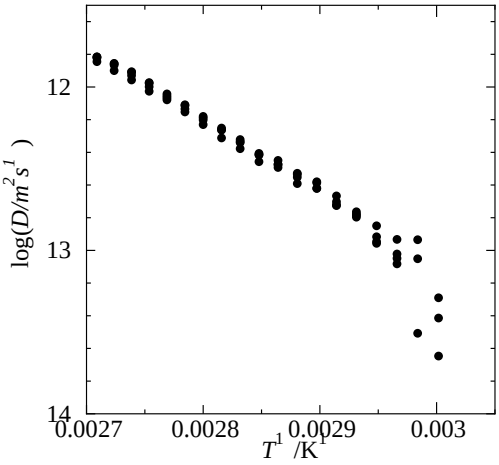

Figure 1. Temperature-dependence of the diffusion coefficient in the plastic crystalline phase of HME.

IV-M Phase Transition Mechanism of Reentrant Liquid Crystal

When conventional liquid loses its isotropic (I) symmetry and assumes uniaxial orientational order, the nematic (N) liquid crystalline state is formed. The smectic A (S_A) state is characterized by its one-dimensional translational order in addition to the nematic order. It is therefor natural that the phase transition sequence be I-N-S_A on lowering the temperature. However, the reentrant liquid crystal exhibits a transition sequence, I-N-S-N-(S)-crystal (doubly reentrance sequence) on lowering the temperature. The second N phase is called reentrant nematic (RN), and the S to RN transition means that 1-D translational lattice melts on lowering the temperature. Due to this peculiarity, the nature of this transition sequence has been one of the interesting topics in recent liquid crystal research.

IV-M-1 Neutron Small-Angle Scattering of Reentrant Liquid Crystal CBOBP

OISHI, Osamu

The reentrant liquid crystal, CBOBP (4-cyano-benzoyloxy-[4-octylbenzoyloxy]-p-phenylene), exhibits a transition sequence, I-510-N-458-S_{Ad}-431-N-415-S_{A1}-398-crystal(The transition temperatures are shown in K.) on lowering the temperature.

We made neutron diffraction study to clarify the structure of the liquid crystalline phases and hence to clarify the microscopic mechanism of this phenomenon. For this purpose a compound with perdeuterated chain, CBOBP-d17 was prepared. SANS-U instrument was used at an wavelength of 7 Å with a velocity selector.

Figure 1 shows the magnitudes of the scattering vectors of the diffraction peaks. The two data points at lowest temperatures correspond to the supercooled S_{A1} phase. It is revealed that two peaks coexist in the RN phase.

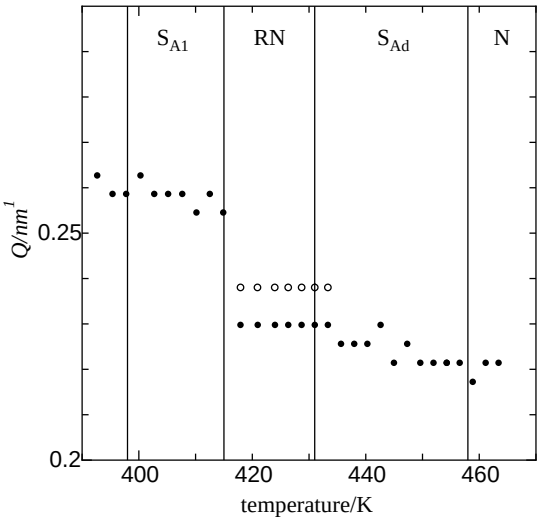

Figure 1. Magnitudes of the scattering vectors in the liquid crystalline phases.

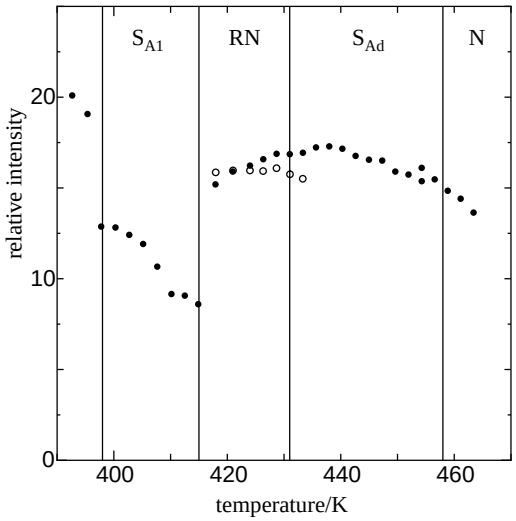

Figure 2. Relative intensities of the diffraction peaks.