

Dynamics of an ionic liquid C16mimPF6 in SmA liquid crystal and liquid phases

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“ Ionic liquids ” are novel ionic compounds which are in liquid states around room temperature. They exhibit many unique physical properties, e.g., low vapor pressure, amphiphilicity, high ionic conductivity, etc, and so have been studied extensively both from scientific and industrial points of view. The most popular ionic liquids are alkylmethylimidazolium salts abbreviated as $C_n\text{mim}X$, where n is the number of an alkyl-chain and X is an anion. The most remarkable feature of $C_n\text{mim}X$ is the higher-order structure (nanostructure) consisting of the polar domains formed by imidazolium rings and anions and the neutral domains formed by alkyl-chains [1-3]. Recently, we proved that the nanostructure is the fluctuation of the layer structure in the smectic-A liquid crystalline (LC) phase which appears in $C_n\text{mim}X$ ($n > 10$)[4].

The general purpose of the present study is to investigate the difference in the dynamics between the LC and liquid phases and to clarify the motion which characterizes the LC-liquid phase transition. In this experiment, we investigated the coherent scattering for d-C16mimPF₆ using a neutron spin echo (NSE) spectrometer at the National Institute of Standards and Technology in USA. The coherent scattering is predominant for the collective motions corresponding to the $S(Q)$ peak.

Figure 1 shows the $I(Q, t)/I(Q, 0)$ curves obtained by NSE at $Q = 0.2\text{\AA}^{-1}$, corresponding to the collective motions of the layer structure. There are two relaxations. The relaxation time τ of the slower relaxation changed drastically at the transition; the τ of the LC phase was 10 times longer than that of the L phase. On the other hand, at $Q = 0.9\text{\AA}^{-1}$, corresponding to the ionic

correlation, the relaxation time was almost continuous at the transition. These results reflect the fact that the nanostructure in the liquid phase is a sort of fluctuation (short-range order) of the layer structure (long range order) in the LC phase, while the local structures in the polar domains are almost the same in both phases.

References

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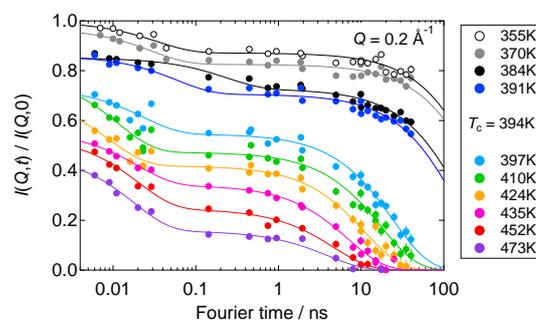


Fig. 1. Intermediate scattering functions $I(Q, t)/I(Q, 0)$ obtained by NSE for d-C16mimPF₆ at $Q = 0.2\text{\AA}^{-1}$