

Collective dynamics of alkyl-methyl imidazolium based ionic liquids with liquid crystalline phase

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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 $C_n\text{mimX}$, where n is the number of an alkyl-chain and X is an anion. The most remarkable feature of $C_n\text{mimX}$ 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 $C_n\text{mimX}$ ($n > 10$) [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 the previous 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. We found that the relaxation time of the layer structure in the LC phase is 10 times longer than that of the L phase. In this experiment, we performed a similar NSE measurement for d-C14mimBr which has an LC phase as in C16mimPF₆.

Figure 1 shows the $I(Q, t)/I(Q, 0)$ curves obtained by NSE at $Q = 0.2\text{\AA}^{-1}$, corresponding to the layer structure. All of these data are for the LC phase since the transi-

tion temperature to the L phase is 451 K. In addition to the faster relaxation, the constant component was observed at all measured temperatures. This result suggests that the slower relaxation of the layer structure is much slower than the relaxation in d-C16mimPF₆. It is of interest that the magnitude of the constant component decreased with an increase of temperature. Further analysis is now in progress.

References

- [1] A. Triolo *et al.*, J. Phys. Chem. B **111**, 4641 (2007).
- [2] O. Yamamuro *et al.*, J. Chem. Phys. **135**, 054508 (2011).
- [3] M. Kofu *et al.*, J. Phys. Chem. B **117**, 2773 (2013).
- [4] F. Nemoto *et al.*, J. Phys. Chem. B, *in Press*, DOI: 10.1021/acs.jpcc.5b01080

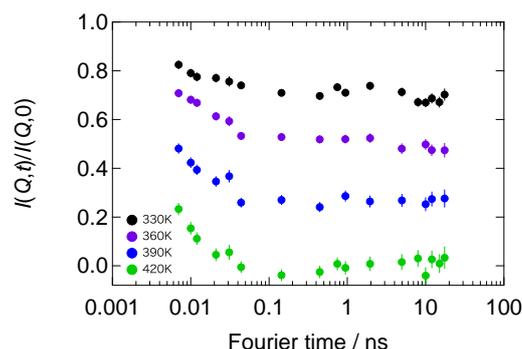


Fig. 1. Intermediate scattering functions $I(Q, t)/I(Q, 0)$ obtained by NSE for d-C14mimBr at $Q = 0.2\text{\AA}^{-1}$