Preparation of Fast Ion Conductive Pathway Using Amphiphilic Ionic Liquid

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Abstract

Amphiphilic derivatives of ionic liquid form self-organized smectic liquid crystalline phase. High ionic conductivity through the smectic layers has been obtained. Ionic conductivity in smectic phase was higher than that in the isotropic liquid phase.

Introduction

Organic ionic liquids contain only ions, and these have a lot of useful properties such as high ionic conductivity, non-volatility, non-flammability, and so on. These ionic liquids have collected keen attention as materials for polymer electrolytes and solvents. On the other hand, amphiphilic ionic liquids form self-assemble and nano-phase separation[1]. We have tried to apply this ionic liquid layer for fast ion conduction. Here we show the design of ion conduction paths with amphiphilic ionic liquid **1**.

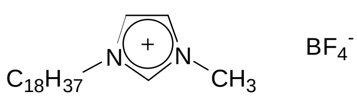

Chart 1 Structure of amphiphilic ionic liquid **1**

Experimental

Amphiphilic ionic liquid **1** was prepared by alkylation of 1-methylimidazole with 1-bromooctadecane, followed by the anion exchange reaction using HBF_4 in an aqueous solution. Samples in isotropic phase were introduced into the layer between glass plate and comb shaped gold electrodes deposited on the glass substrate[2]. And then, the samples form single-orientation in liquid-crystalline phase were confirmed by polarized optical microscope (Figure 1). Dynamic ionic conductivity measurement of the liquid-crystalline molecules was carried out with the complex-impedance method using an impedance analyzer (Schlumberger, Solatron 1260 and a custom set-up temperature controller).

Results and Discussion

Amphiphilic ionic liquid formed smectic phase at temperature between 55 and 203 ^{o}C. Figure 2 shows the ionic conductivity of **1** as a function of temperature. The discontinuous changes of the ionic conductivity were observed at the phase transition temperature. When the liquid-crystalline phase disappears at the isotropization temperature on heating, ionic conductivity decreased. Also, ionic conductivity increased with phase transition from isotropic liquid to smectic phase on cooling cycle. These ion conductive behaviors suggested that orientated ionic liquid layer formed in smectic phase gave faster ion conductive pathway.

Acknowledgement

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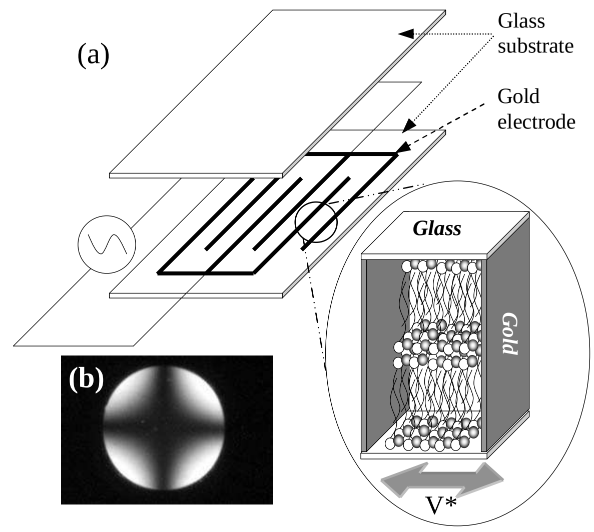

Figure 1 Schematic illustration of single orientation for liquid-crystalline molecules **1** in gold electrode cell (a) and conoscopic image (b).

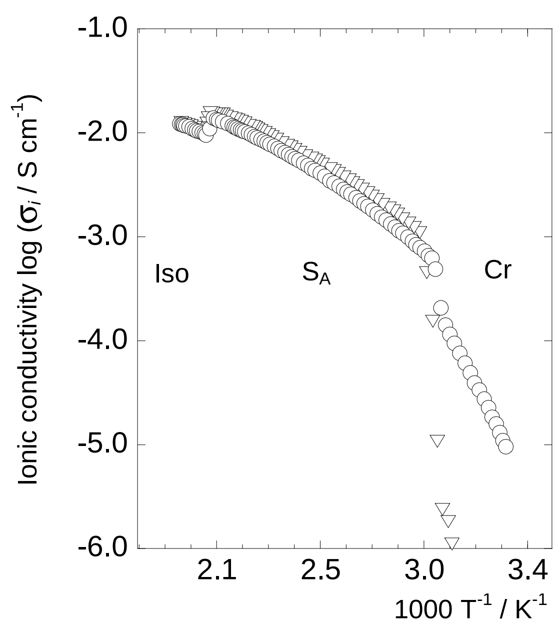

Figure 2 Temperature dependence of ionic conductivity for liquid-crystalline molecules **1** on heating(▽) and cooling (○). Iso = Isotropic liquid, S_A = Smectic A (liquid-crystal), Cr = Crystal

References

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