Preparation of novel sulfonated block copolyimides for proton conductivity membranes

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Abstract

In this article, we have report the proton conductivity of the novel sulfonated block copolyimides with various diamine compositions and block chain lengths synthesized by chemical imidization using a two-pot procedure. It was clear that the proton conductivity of the membranes measured as functions of the relative humidity and temperature using four-point-probe electrochemical impedance spectroscopy strongly depended on the block chain lengths and increased with an increase in the block chain lengths. The proton conductivity of NTDA-BDSA-b-6FAP (140/60) as the block copolyimide membrane was approximately 0.46 Scm^{-1}, which indicated a higher value when compared to that determined for Nafion.

Introduction

The study of proton conducting polymers has attracted much attention due to their application in fuel cell systems. Recently, many efforts have gone into the development of novel polymer electrolyte membranes based on the sulfonated polyimide, sulfonated polysulfone, and sulfonated polystyrene. The proton conductivity of the block copolymer expects to indicate a high value due to ionic channels formed by microphase or nanophase separation between the hydrophilic proton transport sites and the hydrophobic domain.

In this study, the sulfonated block copolyimides were synthesized by the two-pot procedure. The structure of the copolyimide is showed in Fig.1.

Results and discussion

The sulfonated block copolyimides with the different block chain lengths were synthesized by chemical imidiation using a two-pot procedure. The degree of imidization of the sulfonated copolyimides was determined by ^{1}H-NMR spectroscopy. The ^{1}H-NMR result showed that the sulfonated polyimides synthesized by the chemical imidization were completely imidized. The IEC values for the random and block copolyimide membranes were determined by the titration.

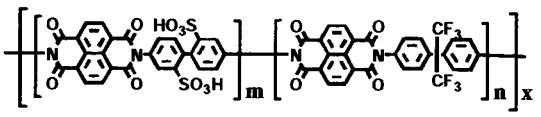

Fig.1. Chemical structure of sulfonated block copolyimide (NTDA-BDSA-b-6FAP).

In this work, the proton conductivities of the sulfonated block copolyimide membranes increased with an increase in the lengths; NTDA-BDSA-b-6FAP (140/60) >NTDA-BDSA-b-6FAP(112/48)>NTDA-BDSA-b-6FAP(70/30)>NTDA-BDSA-b-6FAP(49/21). We considered that the block chain length in the sulfonated block copolyimide may have an influence on the ionic channel distribution, which is one of the important factors that dominate the proton conductivity. In general, the proton conductivity for most polymer electrolyte membranes based on the sulfonated polyimide is well known to significantly decrease at low humidity. However, the conductivity of the block copolyimide membranes showed a humidity-dependence like Nafion and indicated much higher values than the random copolyimide membrane at low humidity.

References

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