트리아졸을 함유한 수소이온 전도성 전해질막의 제조와 고온연료전지에의 응용

이동훈, 박선준, 강용수
한양대학교 화학공학과

Preparation of proton conducting gel electrolyte membranes containing triazoles and their application to high temperature fuel cells

Dong Hoon Lee, Sun Jun Park, and Yong Soo Kang
Department of Chemical Engineering, Hanyang University

1. Introduction

Polymer electrolyte membrane fuel cells have attracted considerable attention as potential new energy devices [1-3]. Perfluorosulfonic acid polymers such as Nafion are the most widely used polymer electrolyte membranes for fuel cells because they give high proton conductivity and good chemical, mechanical and thermal stability. However, they have high proton conductivity only when saturated with water, which limits the operating temperature of these fuel cells to about 90°C [4]. The proton conduction in the PEM strongly depends on the water contents, the conductivity decreases with evaporation of the water above 100°C, resulting in poor cell performance [4-6]. Therefore, there is a tremendous demand to develop novel materials possessing low or non humidifying condition with a high ionic conductivity.

Ionic liquids have been a recently interest for various applications based on their unique properties such as thermal stability, non volatility, and relatively high ionic conductivities. In particular, acid-base complex ionic liquids show rather high proton conductivites [7-9]. It is also possible to utilize non-volatile ionic liquids as a solvent to improve the proton conductivities of heterocycles such as triazoles and imidazoles. Such heterocycles show a similar proton conduction mechanism to Grotthuss mechanism as in water and it has rather high proton conductivity without humidification [10-12].

However, the mixture of ionic liquid and triazole is a liquid at room temperature, providing leaching-out problems during operation and no mechanical strength. Thus it is necessary to provide proper mechanical properties and to block the leaching-out of the liquid mixtures. One example is to make polymers containing the triazoles, yielding a poor ionic conductivity. Therefore we employed poly(ethylene glycol) diacrylate (PEGDA) to solve the problems of leaching-out and poor mechanical strength.

2. Experimental

Poly(ethylene glycol) diacrylate (PEGDA, MW= 743 g/mol) and heterocycles such as 1*H*-1,2,4-triazole were purchased from Aldrich Chemical Co. Ionic liquids such as 1-butyl-3-metylimidazolium tetrafluoroborate ($BMImBF_4$, >98%) and 1-butyl-3-metylimidazolium trifluoromethanesulfonate ($BMImCF_3SO_3$, >98%) were obtained from C-TRI Co.

3. Results and Discussion

The proton conductivity through the ionic liquids/triazole/PEG composite membranes is shown in Figure 1. Proton conductivities were measured over the temperature range of 80 to 130°C under anhydrous condition.

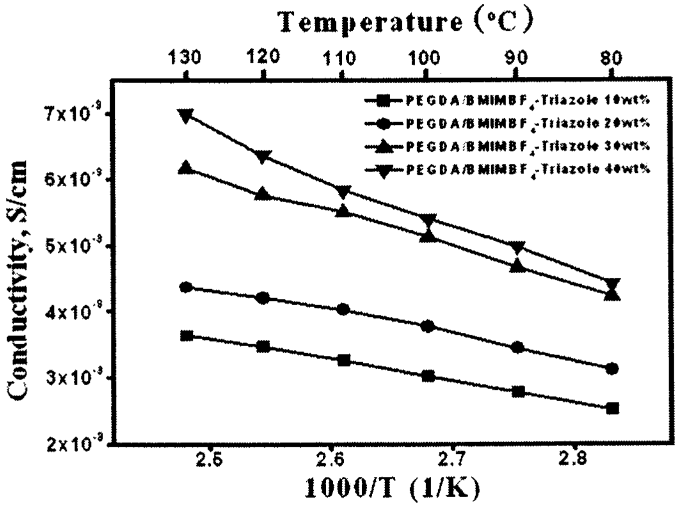

Figure 1. Proton conductivity for ionic liquid/triazole/PEGDA composites microporous membranes as a function of temperature with varying ionic liquid/triazole concentration.

The results showed that the proton conductivity of ionic liquids/triazole/PEG composite membranes slightly increased with increasing ionic liquids/triazole concentration. The proton conductivity also increased with increasing temperatures expected. The obtained results suggested that the proton exchange membranes comprising the mixtures of the triazole and ionic liquid blended in the PEGDA could be utilized as an alternative proton exchange membrane for high temperature applications.

4. Conclusions

Proton conducting gel electrolyte membranes were prepared and utilized to prepare PEMs for high temperature operation. Composite PEMs containing heterocycles mixed in PEGDA matrix showed high proton conductivity with appropriate mechanical strength without humidity at temperatures above 100°C. Investigation of immobilized triazole may lead to new membranes with high proton conductivity for high temperature PEM fuel cells to be operated at temperatures above 100°C.

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