4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

N,N-diethylmethylammonium-based protic ionic liquids for intermediate temperature fuel cells

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Accepted for publication on 10th January 2015

Polymer electrolyte fuel cells (PEFCs) have been already commercialized for home-use and their application is now being extended to mobile-use such as fuel cell vehicles. Perfluoro-sulfonated polymers such as Nafion® have been used as electrolytes in PEFCs because of high proton conductivity and good chemical stability. However, those electrolytes have to be used under humidified conditions in order to maintain high proton conductivity. As a result, the PEFC system becomes large to equip humidifying apparatus and the operating temperature is limited at 80 °C although the catalyst activity is strongly reduced by CO poisoning at low temperatures. Thus, new electrolyte materials, which can be used without humidification at higher temperatures than 100 °C, are needed, particularly for mobile applications.

Ionic liquids (ILs), which are molten salts at room temperature, have attracted considerable attention as PEFC electrolyte materials at intermediate temperatures (higher than 100 °C) under non-humidified conditions because of their special characteristics such as non-volatile, non-flammability, high thermal stability and electrochemical stability. Many kinds of ILs have been proposed and investigated as electrolytes for intermediate temperature PEFCs. However, ILs produced for fuel cells still have some problems for practical application. Large over-potential and slow kinetics of electrochemical oxygen reduction reactions (ORRs) on Pt catalyst electrode are critical ones.

So far, we have investigated interfacial phenomena between Pt electrode and ILs in the course of ORRs by *in-situ* FT-IR spectroscopy combining with electrochemical analyses, and revealed that the adsorption and desorption behavior of the anion in ILs strongly affects the ORR activity. This result shows that the ionic liquid comprising an anion weakly absorbed on Pt surface, which can be easily released by applying a potential, is appropriate for the ORR. In this study, we synthesized a series of ILs from *N,N*-diethylmethylamine (dema) and three kinds of fluoroalkylsulfonic acids having different chain lengths ($H\text{-}SO_3(CF_2)_nF$, n = 1~3), and investigated the effect of fluoroalkyl chain length on the ORR activity of Pt in the dema-based ILs to discuss the appropriate design of ILs for intermediate temperature PEFCs.

Keywords: intermediate temperature fuel cell; ionic liquid; fluoroalkyl chain length; oxygen reduction reaction