CHAPTER I
INTRODUCTION

Polymer electrolyte membrane fuel cell (PEMFC) is the most attractive alternative energy for electricity production by using electrochemical reactions of fuel and oxidant. It is considered to be a promising candidate system because of high efficiency, rapid start-up and fuel flexibility. Moreover, PEMFC can be used with practical designs with high output for the use in automobiles and mobile electronic devices.

Polymer electrolyte membrane (PEM) is one of the key components in PEMFC as a proton conductor, gas separator and electrical insulator. Up to now, the well known commercial membrane for PEMFC is Nafion® which considered to be a standard polymer electrolyte because it performs an excellent proton conductivity and good chemical and mechanical stability. However, the limited operation at high temperature (above 100 °C) is a main problem of Nafion® because of water evaporation. Therefore, this limitation leads us to development of alternative material for practical use at the temperature range of 100 °C -150 °C.

The fact that the operating temperature above 80 °C is always required to maximize the cell performance, heterocyclic membranes are promising molecules due to their high thermal stability and amphoteric structures that allow proton transfer under hydrogen bond network. As reported in the past, heterocyclic have been used in PEMFC and the proton conductivity of these materials is still the point to be improved.

To our understanding, the molecular structure as well as the factors related to the proton conductivity is a key guideline to effectively develop the conductive material. In the case of heterocycles, i.e., imidazoles, benzimidazoles, etc., the hydrogen bond among the molecules is known as a key factor related to the proton conductivity. The point is how the heterocycles developed their hydrogen bond networks and molecular mobility to improve proton conductivity performance. In order to answer this question, it is necessary to focus on systematic heterocycles and their structures including the relationship between the structures and the proton conductivity performances. The present work, therefore, proposes alkyl urocanates as model compounds and the molecules are systematically developed from one to seven methylene units with imidazole molecules to improve molecular mobility with certain level of hydrogen bond network. The relationships of hydrogen bond network and molecular mobility related to the temperature and the consequent proton conductivity are investigated to clarify how the balance of hydrogen bond network and molecular mobility play the role on proton transfer.

Considering the proton transfer through hydrogen bond network of heterocycles in polymer matrices, synchronized effect of water and imidazole molecules are involved for enhancement of proton conductivity efficiency. The fact that the hydrogen bond network of water clusters is an efficiency proton channel for PEM as known as Nafion® or/and sulfonated poly(ether ether ketone), SPEEK. By blending alkyl urocanates, their low melting temperatures exhibit proton transfer behavior similar to water clusters. With this system, it comes to our question how we can identify synchronized effects of water and imidazole molecules on proton transfer. In order to answer this question, blending systems of alkyl urocanates are considered. The structural changing related to the temperature and the consequent proton conductivity is investigated.

According to SPEEK, SPEEK are known as a good polymer electrolyte membrane. Considering structure of SPEEK polymer, there are a rich of aromatic ring in polymer backbone which might performs thermochromic property. The specific preparation of SPEEK thin film might induce pre-orientation of polymer chain. Therefore, it comes to our question that how SPEEK thin film can performs reversible thermochromic property under high temperature. In order to clarify this phenomenon, temperature dependence technique with basic characterization are used to investigate.