CHAPTER I
INTRODUCTION

At present, conventional proton exchange membrane fuel cells (PEMFCs) use Nafion as the electrolyte. Nafion is the trademark (produced by DuPont) of perfluorosulfonic polymers, composed of carbon-fluorine backbone chains and perfluoro side chains with sulfonic acid ion-exchange groups. It shows excellent proton conductivity due to the presence of water molecules in its structure. However, it is expensive and the loss of proton conductivity of Nafion at temperature above 80 °C can be occurred due to the lower-water content, resulting in the decrease of cell performance. Generally, membranes for fuel cell should have many properties such as non-fluorinated membrane, high chemical and mechanical stability at elevated temperature, and good performance at low relative humidity (R.H.). They should also be impermeable to H_2 and O_2. In addition, they must be easily synthesized from available and low-cost starting materials.

The development of new polymer system is one of the choices in order to improve its high-temperature performance. These membranes are made with various organic polymers. However, this choice is not suitable for application in electrochemical processes because of their low specific surface area and environment-dependent structure. Therefore, scientists are turning to new alternative that is the synthesis and development of total inorganic membranes such as TiO_2, SiO_2 and ZrO_2 that possess high proton conductivity, accompanied by good chemical and thermal stability, high porosity, and high specific surface areas (Inorganic Mesoporous Membrane). Moreover, these materials may be deposited on electrode better than that of polymer membranes. Furthermore, an inorganic membrane process is also simpler and more economical than other methods, as compared with organic membranes.

For practical use in fuel cells, the electrolyte materials must be in the form of flexible and gas-tight thick film. For this reason, great interest has been focused on the development of inorganic/organic hybrid membranes. Inorganic membranes can be modified by using polymers as binder in order to improve mechanical properties of membranes since the organic part enables the membrane to have elastic and hydrophobic properties and the inorganic component gives high proton conductivity along with hydrophilic properties. Therefore, inorganic/organic composites, which are applicable at higher temperature and under moderate water vapor pressures, are suitable for electrolyte applications.

In the present study, inorganic particles, including titanium dioxide, antimony-modified titanium dioxide and antimony/niobium modified titanium dioxide particles, were prepared by sol-gel method. This method offers a more precise pore-size distribution in the final product, compared to polymeric sol-gel method. The control of pore structure is very important for designing the proton conducting paths. Various inorganic/organic composite membranes were prepared by spin coating. The resulting membranes should provide high proton conductivity at temperature above 100°C, high mechanical, thermal and chemical stability. They should also be impermeable to H_2 and O_2.