High Temperature PEMFCs Using Modified Teflon-Nafion Membranes with Different Chemical Structure

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Proton exchange membrane fuel cells (PEMFC) comprise an ion conducting electrolyte membrane and two electrodes, which also contain that electrolyte and in which the desired electrochemical reactions take place. The high proton conductivity of the membrane, favorable reactant gas permeabilities and chemical and mechanical stability are major factors for the development of highly efficient PEMFCs.

Conventionally proton conducting ionomeric membranes useful in PEMFCs are selected from commercially available membranes, e.g. Nafion, Aciplex, Flemion etc. [1].

Up to now Nafion, a perfluorinated proton-conducting polymer containing hydrophilic sulfonic acid terminated side-chains, is one of the most effective membranes for use in practical PEMFCs. Although some improvements have been made, this polymer still doesn't have some desirable properties such as the ability to support high currents with minimal resistive losses and zero electronic conductivity at elevated temperatures (above 100^{o}C).

At the University of Connecticut, several new modified Nafion membranes incorporating proton conductors, e.g. phosphotungstic acid and zirconium hydrogen phosphate, have been evaluated in order to decrease water loss at elevated temperatures [2] and to improve water distribution in the membrane during operation. The mechanical integrity of the membranes has been enhanced using Teflon mesh as a support.

The objective of the present work is to obtain comparative characteristics of PEMFCs based on Teflon-Nafion membranes modified with proton-conductive electrolytes having different chemical structure and properties.

The PEMFC results obtained for the Nafion-Teflon membranes modified with different solid electrolytes, e.g. zirconium hydrogen phosphate, phosphotungstic and silicotungstic acids, in the temperature range 80-130^{o}C will be presented. All the results will be compared to that of the pure Nafion membrane.

The results of systematic thermogravimetric analysis (TGA) indicating water loss in the membrane at operating temperatures will be reported. Endothermic peaks in the temperature range from 30^{o}C to 300^{o}C showing the difference in phase transition temperatures of the modified membranes will be discussed.

Dependence of ionic conduction and water content in PEMFCs on operating temperature and reactant gas humidity and flow rate will be presented using impedance spectroscopy analyzer at frequency range between 20 KHz to 10 mHz. In particular, the effect of Nafion-Teflon membrane modification with solid proton-conducting electrolytes at operating temperatures indicating the difference in membrane conductivity will be reported.

The voltage-current PEMFC characteristics using various kinds of solid electrolyte in the composite membrane will be compared to results using pure Teflon-Nafion films in the temperature range 80-130^{o}C.

References:

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