Composite Polymer Electrolyte Membrane for High Performance PEMFC

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Polymer electrolyte membrane fuel cells (PEMFC) are of considerable practical interest due to their high powder densities, fast start-up, low emissions and quiet operation [1]. In PEMFC, solid polymer electrolytes work as a structural framework to support the electrodes and transport protons from the anode to the cathode during cell operation. It was well known that the structure of membrane and electrode assembly (MEA) plays crucial roles in the performance of PEMFC.

Much of the research and development works has been focused on Nafion® 117, a membrane developed in 1960's specifically for the chlor-alkali industry, but the limitations to large-scale commercial use include poor ionic conductivities at low humidity or elevated temperatures and high material cost [2]. Thus, the developments of new solid polymer electrolytes have become one of the most important issues for PEMFC study.

Currently, state-of-the-art membranes are Nafion® impregnated Teflon membrane developed by W.L. Gore & Associates. Penner and Martin first prepared composite membranes by impregnation of microporous Teflon film with Nafion® [3]. Kolde *et al*. disclosed the preparation of ultra thin composite membranes, which include a base material of microporous Teflon, Gore-Tex®, and an ion exchange resin such as Nafion® [4,5]. Gore-type membranes have given excellent results in fuel cell because of low ohmic losses resulting from a limited thickness of the base material. However, such composite membrane has relatively low productivity because they were usually prepared by brushing Nafion® solution on porous Teflon films. In addition microporous Teflon support materials, which has large porosity around 80% are relatively expensive material.

In these respects we prepared composite polymer electrolyte membranes by blending Nafion® resin with common polymers such as polyvinylidenefluoride (PVdF) and polybenzimidazole (PBI). They have good water/methanol selectivity and better room temperature and high temperature proton conductivity even at low weight fraction of ion exchange polymer since Nafion® is completely miscible with these non-ionic polymers. Furthermore, This solution blend technique ensures high productivity by means of solvent casting, extrusion or injection molding.

In this report, we will first present the synthesis and characterization of novel Nafion®-based polymer blend electrolytes membrane for PEMFC.

References

1. G. Inzelt, M. Pineri, J.W. Schultze and M. A. Vorotyntsev, *Electrochimica Acta*, **45**, 2403 (2000).
2. M. Rikukawa and K. Sanui, *Prog. Polym. Sci.*, **25**, 1463 (2000).
3. R. M. Penner and C. R. Martin, *J. Electrochem. Soc.*, **137**, 514 (1985).
4. B. Bahar, A. R. Hobson, J. A. Kolde and D. Zuckerbrod, U.S. Patent 5,547,551 (1996).
5. G. Rusch and J. A. Kolde, U.S. Patent 6,130,175 (2000).