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Hydrolytically Durable Cross-linked Sulfonated Polyimide-Silica Nanocomposite Membranes for Fuel Cell Applications

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Sulfonated polyimide (SPI) membranes have been considered as one of promising proton exchange membrane materials for fuel cell applications such as PEMFC and DMFC because of high proton conductivity, thermal, chemical and mechanical stability. However, SPIs with phthalic imide structure shows very poor hydrolytic stability, and resultantly brittleness or cracking due to chain scission after immersion into acidic water was often witnessed[1]. Furthermore, according to our previous study[2,3], the tendency in the cell performances based on sulfonated polyimide membranes was significantly dependent upon the hydrolytic stability. This intrinsic problem of sulfonated polyimides can be improved by using six membered-naphthalenic dianhydride and sulfonated diamines. Crosslinking in hydrolytically unstable sulfonated polyimide membranes also helps to improve their membrane stability. In this present study, nano-sized fumed silica (Aerosil 200 or Aerosil 812) was incorporated into the SPI membranes to reduce direct attack of fuel and water molecules, and hydrogen peroxide radicals on the membrane. To prevent self-aggregation of the fine inorganic particles and consequent heterogeneous mixing with organic polymer, some kinds of non-ionic amphiphilic surfactants were used as a compatibilizer and chemical crosslinker. The effect of inorganic fillers was highlighted with surfactants on the hydrolytic stability as well as proton and methanol transport properties.

References

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