ABSTRACT

Development of Binary and Ternary Component-Based System Membranes for Polymer Electrolyte Fuel Cells

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Polymer electrolyte membrane fuel cells (PEMFC) are considered to be highly promising for future transportation and stationary power generation. The main obstacles preventing their commercialization are high cost of proton conductive membranes, low-proton conductivity at low relative humidity and dehydration and degradation of polymer membranes at high temperatures. The objectives of this study were to design and test a high proton conductive binary/ternary acid-base system/s that can provide a conductivity of approximately 10^{-2} S/cm under anhydrous conditions to support high currents with minimal resistive losses and be thermally stable above 100 ^{o}C. Binary acid-base systems were first synthesized and their proton conduction properties were investigated based on various pKa and pKb values of the acid and base, respectively. The highest proton conducting binary systems were incorporated into polymers to form ternary acid-base systems using the solution casting technique. Analyses of the binary and ternary systems included ionic conductivity, thermal stability, morphology, water uptake (WU), ion exchange capacity (IEC), methanol testing and fourier transform infrared spectroscopy (FTIR). Poly(vinylidene Fluoride-co-Hexafluoropropylene) (PVdF-HFP) was chosen based on its high dielectric constant which support for dissociation of salt, low crystallinity for improved ionic conductivity and low glass transition temperature which makes it a suitable polymer host. Binary acid-base/2-8 systems had proton conductivities of the order 10^{-2} S/cm to 10^{-1} S/cm and thermal stabilities over 200 ^{o}C whenver imidazole was used as the base. The effect of molecular weight of polymer in a membrane showed that lower molecular weight polymer systems were superior in proton conduction as compared to the higher molecular weight polymer systems. Thermal stability above 200 ^{o}C was achieved for all ternary systems. PVdF-HFP-Oxalic Acid-Dimethylacetamide/5-1-4 system was the best performance membrane with 0 % WU, thermal stability above 200 ^{o}C and proton conductivity of the order 10^{-3} S/cm at 150 ^{o}C.

Keywords: Marisa Singh; PEMFC; DMFC; polymer electrolytes; acid-base.