ABSTRACT

Proton exchange membrane fuel cell (PEMFC) is commonly used to generate electricity in three primary applications: transportation, stationary, and portable electronics. The development of an electrolyte membrane by Chitosan material is appealing for PEMFC due to its lower methanol cross-over, biodegradable, widely available and lower cost. However, it has lower proton conductivity as well as poor mechanical, thermal and dimension stability. For potential applications, Chitosan membrane is modified with polyvinyl alcohol (PVA), fillers, cross-linking agents and ionic liquid to improve its properties. The crosslinking of Chitosan-PVA blend by H_2SO_4 improves ion transport capacity, proton conductivity as well as mechanical and thermal properties. The addition of filler likes red mud, zirconia and multiwall carbon nanotubes to the Chitosan-PVA blend improves bound water content. Moreover, the addition of fillers deplete crystalline domain of the membrane and reduces glass transition temperature. The addition of ionic liquid and hygroscopic zirconia to the CP blend significantly increases proton conductivity and reduces methanol permeability. The highest proton conductivity was observed in a zirconia and ionic liquid modified CP blend. Moreover, it provides the lowest methanol permeability of 9.4×10^{-8} cm^2/s which is significantly lower than the commercial N117 membrane (2.74×10^{-6} cm^2/s). At 70°C, zirconia and ionic liquid modified CP blend provides the highest power density of 97 mW/cm^2 at a current density of 440 mA/cm^2. A one dimensional analytical model of direct methanol fuel cell (DMFC) is proposed by modelling the kinetics of methanol transport at anode flow channel (AFC), membrane and cathode catalyst layer. The proposed model is validated with the experimental results and can be used to predict DMFC performance.

Key words: PEMFC, IEC, Bound Water, Proton Conductivity, Methanol Permeability, Power density, Polarization Curve, Anode Flow Channel, Analytical Model.

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