ABSTRACT

This dissertation presents a detailed study on the synthesis of nanocomposite membranes of sulfonated polyphenylsulfone embedded with carbon nanoball fillers. The effect of various synthesis parameters such as temperature, time, and concentration of the sulfonating agent on sulfonation of polyphenylsulfone, and the production of carbon nanoballs by non-catalytic chemical vapour deposition method were investigated. The synthesized carbon nanoballs were added to the polyphenylsulfone membrane in order to optimize the mechanical properties of the membrane. Furthermore, the effect of addition of low volumes of carbon nanoballs on the morphology and membrane properties was investigated.

The sulfonation of polymeric membrane was characterized by Proton Nuclear Magnetic Resonance (^{1}H NMR) which confirmed the sulfonation of polyphenylsulfone. The Transmission Electron Microscopy (TEM) analysis showed that produced CNBs had necklace structure with almost uniform size ranging between 40 to 60nm. Bruner-Emmett-Teller (BET) analysis showed that CNBs had less impurities with pore volume and diameter of 0.0316 cm3/g and 16.7nm, respectively. From TGA result, it was observed that CNBs were thermally stable. Raman analysis indicates that CNBs were non conductive, a property which avoids unnecessary short circuits in the functioning of the fuel cells.

Nano composite membranes with varying loading levels from 0.25 wt% to 4 wt% were prepared using ultrasonication at varying amplitudes of 20%, 60% and 75%, and simple evaporative casting technique. The TGA graph shows that the addition of carbon nanoballs has significantly increased the thermal stability of SPPSU membrane and all the composite membranes prepared with varying CNB loading showed similar decomposition profile. The nanocomposites prepared at 60% amplitude produced homogenous membranes; and the membrane with 1.75wt% CNB loading had high percentage resilience and satisfactory water uptake capacity than other membranes. The results confirmed that the addition of CNBs in low volumes increase the thermal stability and percentage resilience which are very crucial for fuel cell applications.