Abstract

The research in fuel cells is one of the most growing fields in the area of alternative energy sources to mitigate several issues related to energy and environment. A proton exchange membrane (PEM) is considered as a unique ion-selective transport channel that serves to transfer protons from anode to cathode as well as providing a barrier for fuel gas, oxidant and electrons in high performance proton exchange membrane fuel cells (PEMFCs). Nafion® or Flemion® is well known commercially available PEM materials due to their good physical and chemical stability together with high proton conductivity. However, these polymers are not only expensive but suffer from few limitations such as low operational temperature (fuel cell temperature < 80 ºC), high methanol and gas permeability. In addition, these polymers show poor proton conductivity at high temperature and low humidity. Such drawbacks have stimulated us to find aromatic sulfonated polymers as alternative PEM materials having high proton conductivities, low permeability to fuel and oxidants, high thermal, mechanical and chemical stability.

Thus, the principal goal of our present research was to introduce the flexible groups like ether, sulfone etc. as well as fluorinated groups such as $–CF_3$ or other fluorinated monomer like Quadribisfluoro (QBF) into SPAE polymer backbones by an efficient approach for the improvement of structural architecture and desired properties for PEMs such as enhancement of mechanical strength, thermal and chemical stability (mainly oxidative stability), proton conductivity with reduction of fuel crossover. The C-F bond in the structure of the polymer imparts high thermal stability, good oxidative and hydrolytic stability, high tensile strength, and more significantly, distinct phase separated morphology which is essential for better water management and ion transport pathway with high proton conductivity. In addition, the bulky $–CF_3$ groups disrupt the inter-chain packing density and due to this reason the fractional free volume (FFV) of the polymers become enhanced which in turn increases the solubility and processability of the SPAEs. It was also planned to control the properties of the polymer by varying the functionality, polarity and the bulkiness of the preferred monomer units. Additionally, modern scientific and methodological works based on side-chain grafting, nano-technique and so on becomes more attractive protocol to develop the SPAES copolymers as a proton exchange membrane for their successful exploitation in fuel cells.

Keywords: *Fluorinated cardo poly(arylene ether sulfone)s, Thermal and mechanical stability, Oxidative stability, Water Uptake, Proton conductivity with phase separated morphology*.