Abstract

Fuel cells are an efficient and emerging solution to the development of clean, sustainable and environmentally friendly power source devices. Many researchers from the academic and corporate world are involved in the development of proton exchange membrane (PEM) electrolyte material for fuel cells. The PEM is a proton transporter and an electron insulator as well as the separator between the fuel and the oxidant in fuel cells. It is also a highly efficient in converting chemical or bio-chemical energy into electrical energy. Nafion® is a poly(perfluorosulfonic acid)-based PEM material that exhibits well phase-separated morphology between the hydrophilic (ionic clusters) and hydrophobic (backbone) domains, generally required for high proton conductivity. Moreover, these membranes are highly stable in both oxidative and reductive environmental conditions owing to its perfluorinated backbone. The proton conductivity of Nafion® is influenced by temperature and relative humidity which stimulates the development of alternate materials.

Among the various PEM materials, sulfonated polyimide membranes are one of the potential candidates known for their high thermal and chemical stability, excellent film forming ability, strong resistance to fuel crossover and high proton conductivity. However, there are some problems persist in terms of poor solubility, insufficient hydrolytic and oxidative stability owing to the high sensitivity of the imide rings. To avoid these difficulties, the objective of this research is to incorporate semi-fluorinated bulky moieties like 3F (-CF_3) or fluorenyl or benzyl ether or methoxy in the polymer repeat units. These moieties not only enhance solubility of the polymers, thereby improving their processability through solution casting route, but also improve the peroxide radical resistance of sulfonated co-polyimides. Additionally, these groups help in obtaining a better phase separated morphology, which is responsible for attaining high proton conductivity. However, the cross-linking helps to improve the dimensional stability of the membranes and to obtain a distinct well phase-separated morphology, which is accountable for higher proton conductivity of the polymer membranes. In conclusion, we have correlated the various PEM properties with chemical structure, composition, functionality and molecular design.

Keywords: Sulfonated polyimide, Proton exchange membrane, Peroxide radical resistance, Morphology, Fluorenyl groups, Trifluoremethyl groups.