Abstract

Proton exchange membrane fuel cells (PEMFC) are one of the most promising clean energy technologies under development. Proton exchange membrane (PEM) is a key component of PEMFC. An ideal PEM material must possess several characteristics such as high proton conductivity, low electrical conductivity, high fuel cross – over resistance, good mechanical and thermal properties, hydrolytic and oxidative stability and low cost. The perfluorosulfonated membranes, in particular Nafion have been widely used as a material of choice and technology standard due to its good proton conductivity and good thermal and mechanical stability. Owing to the limitations associated with Nafion such as high cost, poor fuel barrier properties and instability at operating temperature above 80°C many synthetic polymers emerged as a promising alternative to the state of art perfluorosulfonated membranes. The safe disposability through biodegradation after service life is also an important consideration for any useful polymeric materials

The present investigation is aimed at the development and characterization of cost effective and eco – friendly polymer electrolyte membranes based on chitosan, a natural polymer for fuel cell applications. The modifications of chitosan using combination of different sulfonic acid dopant (methane sulfonic acid and sodium salt of dodecylbenzene sulfonic acid) and sulfuric acid as a cross linking agent exhibit improvement in water uptake and mechanical stability. The presence of dopant facilitates the process of proton transport but increases the methanol cross – over of the membranes. The synergistic improvement in hydrolytic stability has been observed after cross – linking of the membranes. Another type of chitosan membranes based on silica supported silicotungstic acid (IHPA) was synthesized. The silica supported silicotungstic acid (IHPA) was synthesized by acid – catalyzed condensation reaction between silicotungstic acid (SWA) and tetraethyl orthosilicate (TEOS) using sol – gel process. The effect of IHPA content on mechanical, thermal and electrochemical characteristics of modified chitosan membranes and its application as PEM material for fuel cell has also been investigated. Some membranes were also prepared from modification of chitosan by polyaniline coated nanosilica. Electrochemical synthesis of polyaniline at suitable reaction conditions exhibits graphene – like ultra – thin layered structure. Hydrophilic nanosilica was coated with polyaniline nanosheets using ultrasonication method. The hybrid nanocomposites of the polyaniline coated nanosilica in chitosan matrix improves the fuel cross over resistance, water retention ability and proton conductivity and thereby its

applicability in PEMFCs. Blend polymers where chitosan is the major component and SPVDF as minor component were also used to prepare polymer electrolyte membranes. The physico – chemical interaction among the blend components was confirmed by FTIR, DSC and morphology. Blending of chitosan with SPVDF reduces the methanol cross over and improves ion exchange capacity and proton transfer through the membranes. The reduction in methanol cross over and improvement in proton conductivity are best balanced at 10 wt% SPVDF content.

Keywords: chitosan, direct methanol fuel cell, heteropoly acid, polyaniline. polymer electrolyte, proton conductivity.