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Novel proton conducting membranes based on cross-linked sulfonated polyphosphazenes and poly(ether ether ketone)

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Abstract:

Two series of membranes A and B were designed and prepared by the following synthesis protocols where the cross-linked membranes were composed of highly sulfonated poly(ether ether ketone) (SPEEK) as the acidic component and polyphosphazenes backbone as the basic component. Membrane A was synthesized based on the graft-onto reaction between brominated poly[(4-methoxyphenoxy)(4-methylphenoxy)phosphazenes] (PMMP-Br) and SPEEK3 polymers, while membranes B were obtained by the reaction of bromomethyl groups of polyphosphazenes with triethylamine and simultaneously combined with various amounts of SPEEK3. All the membranes were characterized chemically, thermally, and mechanically by a set of technical means. Polyphosphazenes were found to constrain to a large extent the water uptake and swelling when blended with highly sulfonated PEEK providing sufficient mechanical strength without over-swelling. Specially, the advent of sulfonated single-walled carbon nanotubes (SCNT) in the membrane A led to the hybrid membrane A2:1-SCNT with favorable properties. It exhibited a satisfying proton conductivity of 0.132 Scm^{-1} at 80 °C and a very low methanol permeability of 2.16×10^{-7} cm^2s^{-1}, and retained considerable thermal stability as well as mechanical strength. Also, the fuel cell performance of A2:1-SCNT at 25 °C was higher than that of recast membrane A2:1.

Keywords:

Polyphosphazene, Poly(ether ether ketone), Proton exchange membrane fuel cell, Sulfonated single-walled carbon nanotubes, Cross-linking.

1. Introduction

Among the several kinds of fuel cells, proton exchange membrane fuel cell (PEMFC) is the most mature electro-chemical system which converts chemical energy into electrical energy through electrochemical reactions rather than a combustion