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Synthesis of sulfonated (ether ether ketone) based membranes containing poly(4-styrenesulfonic acid) and its excellent performance for direct methanol fuel cells

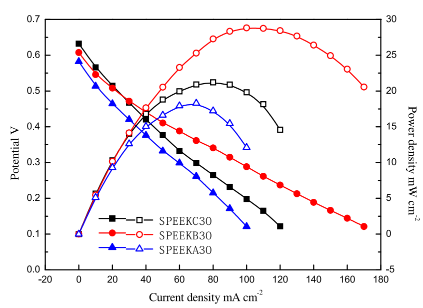
Tao Yang*, Linyan Meng, Ning Huang

School of Chemistry Engineering, Huaihai Institute of Technology, Lianyungang, Jiangsu 222005, China

HIGHLIGHTS

- ► The blend membranes based on SPEEK and PSSA are prepared.
- ► The max power density is 28.82 mW cm^{-2} at 100 mA cm^{-2} (2 M methanol, 80 °C).
- ► A moderate sulfonated PEEK can display excellent performance by doping with PSSA.

GRAPHICAL ABSTRACT



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ABSTRACT

A series of blend membranes based on sulfonated poly(ether ether ketone) and poly(4-styrenesulfonic acid) are prepared by solution casting method. The conjunction of the two polymers is evaluated by Fourier Transform Infrared Spectroscopy technique. The thermal stability is determined by Thermogravimetry Analysis. The blend membranes are investigated in terms of swelling behavior, methanol permeability and proton conduction. The Uptake in water and methanol solution distinctly increases with the increasing of the poly(4-styrenesulfonic acid) content. Methanol permeability slightly increases with the increase of the poly(4-styrenesulfonic acid) content and then reaches to a stable value. The proton conductivity is improved with increasing of the poly(4-styrenesulfonic acid) content. The calculated activation energy for proton transportation is ~6 kJ mol^{-1}, which shows that proton can easily conduct through the polymer network. The blend membranes containing 30 wt.% of poly(4-styrenesulfonic acid) are applied in the practical direct methanol fuel cells and their polarization curves with 2.0 mol L^{-1} methanol solution are measured. The max power density is as high as 28.82 mW cm^{-2} at 100 mA cm^{-2} (80 °C). All the results indicate that these membranes based on sulfonated poly(ether ether ketone) and poly(4-styrenesulfonic acid) show good prospect in direct methanol fuel cells.

1. Introduction

Direct methanol fuel cells (DMFCs) have received much attention due to their advantages such as high energy density, compact structure, environmental friendly, etc [1,2]. During the past decades, much research has been devoted to the investigation of the key components of DMFCs [3,4]. The proton exchange membranes (PEMs) have been extensively studied on the basis of their manifold function [5–11]. PEMs are the crucial part of DMFCs functionally and structurally, which are sandwiched between the anodic and cathodic catalyst layers. PEMs have to separate the fuel and oxidant absolutely and transport the protons through the

* Corresponding author. Tel./fax: +86 518 85895409.
E-mail address: yangtao_hit@163.com (T. Yang).

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