A novel approach on ionic liquid-based poly(vinyl alcohol) proton conductive polymer electrolytes for fuel cell applications

Chiam-Wen Liew, S. Ramesh*, A.K. Arof

Centre for Ionics of University of Malaya, Department of Physics, Faculty of Science, University of Malaya, Lembah Pantai, 50603 Kuala Lumpur, Malaysia

ARTICLE INFO

Article history:
Received 8 December 2012
Received in revised form
4 July 2013
Accepted 23 July 2013
Available online 17 August 2013

Keywords:
PVA
Ionic liquid
Proton conductivity
Fuel cell
Power density

ABSTRACT

The preparation of proton conducting-polymer electrolytes based on poly(vinyl alcohol) (PVA)/ammonium acetate (CH₃COONH₄)/1-butyl-3-methylimidazolium chloride (BmImCl) was done by solution casting technique. The ionic conductivity increased with ionic liquid mass loadings. The highest ionic conductivity of (5.74 ± 0.01) mS cm⁻¹ was achieved upon addition of 50 wt% of BmImCl. The thermal characteristic of proton conducting-polymer electrolytes is enhanced with doping of ionic liquid by showing higher initial decomposition temperature. The most conducting polymer electrolyte is stable up to 250 °C. Attenuated total reflectance-Fourier Transform Infrared (ATR-FTIR) confirmed the complexation between PVA, CH₃COONH₄ and BmImCl. Polymer electrolyte membrane fuel cell (PEMFC) was fabricated. This electrochemical cell achieved the maximum power density of 18 mW cm⁻² at room temperature.

Copyright © 2013, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Depletion of non-renewable fossil fuel catalyzes the development of environmentally friendly alternative energy sources. Fuel cells are promising candidates as power sources for a wide range of applications, ranging from portable devices to electric vehicles [1,2]. Fuel cells are of great interest in the recent research due to their attractive properties. They offer many advantages, such as environmentally benign, high energy efficiency and lower emission of pollutants [3,4]. Fuel cells also do not require the need for rapid recharging process in the presence of electricity compared to the lithium rechargeable batteries [5]. Apart from that, fuel cells exhibit higher energy density than the batteries [6]. The main component in PEMFCs is the proton exchange membrane (PEM) which is used as proton (or charge carriers) provider from anode to cathode. The basic requirement of PEM is the membrane must be proton conductive with some satisfactory properties like excellent mechanical strength and chemically stable. Perfluorosulfonated membrane, Nafion produced by Dupont has widely been used as host polymer in PEMFCs. However, high methanol transfer is the main shortcoming of using Nafion as primary polymer membrane in fuel cells [6,7]. High methanol crossover may cause the loss of fuel, slow methanol oxidation kinetics and formation of carbon monoxide (CO) intermediate on the platinum catalyst layer at the cathode as well as cell polarization. As a consequence, the performance of this electrochemical cell could be decreased...