Characterization of ionic liquid added poly(vinyl alcohol)-based proton conducting polymer electrolytes and electrochemical studies on the supercapacitors

Chiam-Wen Liew, S. Ramesh*, A.K. Arof
Centre for Ionics University of Malaya, Department of Physics, Faculty of Science, University of Malaya, Lembah Pantai, 50603 Kuala Lumpur, Malaysia

A R T I C L E   I N F O
Article history:
Received 25 March 2014
Received in revised form 10 September 2014
Accepted 29 September 2014
Available online 24 October 2014

Keywords:
Poly(vinyl alcohol)
Ionic liquid
Proton conductive
Supercapacitors
Carbon nanotubes

A B S T R A C T
The preparation of poly(vinyl alcohol) (PVA)/ammonium acetate (CH₃COONH₄)/1-butyl-3-methylimidazolium bromide (BmImBr) proton conducting polymer electrolytes is done by solution casting method. Upon inclusion of 60 wt.% of BmImBr, the maximum ionic conductivity of (9.29 ± 0.01) mS cm⁻¹ is achieved at ambient temperature. Ionic liquid added polymer electrolytes exhibit lower glass transition temperature (T_g), crystalline melting temperature (T_m) and crystallization temperature (T_c) than ionic liquid-free polymer electrolyte. The amorphous character of the most conducting polymer electrolyte has been proven using differential scanning calorimetry (DSC). Addition of ionic liquid not only extends the electrochemical potential window of the electrolyte, but also improves the thermal stability of the polymer electrolyte. Activated carbon/carbon black/carbon nanotube electrode is prepared and used in electrochemical double layer capacitors (EDLCs) fabrication. Based on the results, EDLC containing ionic liquid added polymer electrolyte exhibits better electrochemical properties. This EDLC possesses higher specific capacitance than that of supercapacitor comprising of ionic liquid-free-based polymer electrolyte. The specific capacitance of 21.89 F g⁻¹ is obtained from cyclic voltammetry (CV). This value is in good agreement with EIS and galvanostatic charge–discharge findings. The EDLC remains stable upon 250 cycles of charging and discharging processes.

Copyright © 2014, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

Introduction
Electrochemical double layer capacitor (EDLC) is an energy storage-based electrochemical devices. EDLC generally comprises two electrodes and an ion conducting electrolyte. Activated carbon (AC) is a predominant electrode material used in EDLCs because of its attractive properties. Large specific surface area (1000–2500 m² g⁻¹), high porosity and low cost are the advantages of AC [1,2]. However, high microporosity (pore dimension: < 2 nm) of activated carbon could limit the accessibility of charge carriers into the micropores of AC. It is because the bigger ion size serves as a hurdle for diffusion into the smaller pores [1,3]. Therefore, carbon nanotubes...