4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Ionic liquid–added Biopolymer Electrolytes for Electric Double Layer Capacitors (EDLCs) Application

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Accepted for publication on 10th January 2015

Environmental friendly corn starch–based biopolymer electrolytes are prepared by solution casting technique. The effect of ionic liquids on the electrical, structural and thermal properties of polymer electrolytes and the electrochemical properties of fabricated EDLCs is investigated in this work. The effect of counteranion of ionic liquids is also studied in the work. Upon addition of ionic liquids, the ionic conductivity of biopolymer electrolytes is increased significantly. The ionic conductivity of corn starch–based biopolymer electrolytes is increased by three orders of magnitude, from $(2.82\pm0.01)\times10^{-7}$ S cm^{-1} to $(1.47\pm0.02)\times10^{-4}$ S cm^{-1} and $(3.21\pm0.01)\times10^{-4}$ Scm^{-1} with addition of 50 wt.% of 1–butyl–3–methylimidazolium hexafluorophosphate ($BmImPF_6$) and 80 wt.% of 1–butyl–3–methylimidazolium triflate (BmImTf), respectively. Addition of ionic liquids reduces glass transition temperature (T_g), decreases the degree of crystallinity and improves the electrochemical potential window of biopolymer electrolytes. The most conducting biopolymer electrolytes show the lowest T_g and the highest amorphousness as proven in differential scanning calorimetry (DSC) and x–ray diffraction (XRD), respectively. Activated carbon–based electrodes are preapred and used for EDLC fabrication. The electrochemical properties of assembled EDLCs are studied and investigated through cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) at low frequency region and galvanostatic charge–discharge studies. Upon addition of ionic liquids, the specific capacitance of EDLC is improved greatly from 0.18 Fg^{-1} to 36.79 Fg^{-1} for hexafluorophosphate system and 42.44 Fg^{-1} for triflate system. Cycability test on EDLC is also carried out to study the electrochemical stability of EDLC upon 500 cycles of charging and discharging processes. Triflate system shows better electrochemical stability than hexafluorophosphate system.

Keywords: Corn starch; Ionic liquid; EDLC; Capacitance; Electrochemical stability