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Optimization and application of a gel polymer electrolyte in redox capacitors

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Energy production via renewable sources and saving it efficiently has become timely needed issues all around the globe. Supercapacitors have been identified as a class of suitable energy saving devices with respect to conventional capacitors and batteries. There are two types of supercpacitors namely redox capacitors and electrochemical double layer capacitors. In this study, redox capacitors were fabricated using a gel polymer electrolyte (GPE) and two conducting polymer electrodes. GPE was consisted with polyacrylonitrile (PAN) as the polymer, sodium thiocyanate (NaSCN) as the salt and ethylene carbonate (EC), propylene carbonate (PC) as solvents. Hot press method was used to prepare the GPE. Its composition was optimized by varying the salt concentration and measuring the room temperature conductivity. Characterization of redox capacitors was done using Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV). When increasing the salt concentration, the room temperature conductivity increased initially but after a certain concentration, it started to decrease. The increment of conductivity with salt concentration may be due to the increment of charge carriers which are directly responsible for conductivity. The following decrement with further increment of salt concentration may be due to lowering of charge carrier motion upon viscosity enhancement and also due to formation of ion pairs or clusters which do not assist conductivity as per their neutrality. The optimum room temperature conductivity was 1.92×10^{-3} Scm^{-1}. The composition which exhibited the highest room temperature was selected to fabricate redox capacitors. A thin GPE film was sandwiched in between two identical polypyrrole (PPy) electrodes which were galvanostatically polymerized in the presence of sodium perchlorate ($NaclO_4$). Impedance data were gathered using a frequency response analyser and specific capacitance was calculated using the bode plot. The specific capacitance was found to be 85 F/g. Under the CV test, cycling was done at the scan rate of 10 mV/s in the potential window -1.0 V to +1.0 V. The calculated specific capacitance was 102.7 F/g. The difference between the two values obtained by the two methods may be due to the fact that the specific capacitance value obtained using CV test is depending on the scan rate. Apart from that slight difference, the specific capacitance values are seemed to be satisfactory. The combination of the GPE based on PAN and the polymer electrodes based on PPy are suitable to be employed for redox capacitors.

Keywords: Redox Capacitors, Hot press method, Electrochemical impedance spectroscopy, Cyclic voltammetry

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