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THE DOCTORAL RESEARCH ABSTRACTS

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Title : PREPARATION AND CHARACTERIZATION OF EPOXIDIZED-30% POLY (METHYL METHACRYLATE)-GRAFTED NATURAL RUBBER POLYMER ELECTROLYTES FOR ELECTROCHEMICAL DOUBLE LAYER SUPERCAPACITOR

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This dissertation focuses on the preparation and characterization of epoxidized- 30% poly(methyl methacrylate) grafted natural rubber (EMG30)-salt complexes and plasticized EMG30-salt complexes. In the present study, EMG30 as polymer host, lithium trifluoromethanesulfonate (LiCF3SO3) as doping salt and ethylene carbonate (EC) as a plasticizer were used in the preparation of solid polymer electrolytes (SPEs) and gel polymer electrolytes (GPEs). The EMG30 was prepared by performic epoxidation method with various time reaction. Proton nuclear magnetic resonance (1HNMR) and Fourier transform infrared spectroscopy (FTIR) spectra confirm a new peak at 2.70-2.71 ppm and 871 cm-1 which were assigned to the epoxy group. 54.6, 62.3 and 50.0 mol% of epoxidation content were obtained in EMG30 at 6, 9 and 12 hours of time reactions, respectively. SPEs and GPEs based on EMG30 were prepared by the solution cast technique with different weight percent (wt.%) of LiCF3SO3 and EC. FTIR spectroscopy studies have shown that coordination of Li+ ions has occurred on the oxygen (O) atom in the carbonyl (C=O) group, ether group (O-CH3) and epoxy (C-O-C) group of EMG30. X-ray diffraction (XRD) analysis confirmed amorphous nature of EMG30 samples. Thermogravimetric analysis (TGA) have shown that thermal stability of EMG30 is increased compared to pure MG30. The differential scanning calorimetry (DSC) analysis found the epoxidation reaction has increased the Tg value of EMG30 (Tg ≈ - 39.1 °C) due to the restriction of hydrogen bonding. The morphology of the samples has also been investigated using Field-emission scanning electron microscopy (FESEM). EMG30 structure shows the homogeineity and there is no trace of phase separation could be observed by either physical observation or FESEM micrograph. The conductivity of the samples was characterized by the impedance spectroscopy in the frequency range between 100 Hz and 1 MHz. The highest ionic conductivity of SPE containing 40 wt.% LiCF3SO3 in 62.3 mol% EMG30 was 1.10 x 10-3 S.cm-1, which is two orders of magnitude higher than MG30-LiCF3SO3 complexes. Further enhancement of ionic conductivity 62.3 mol% EMG30-LiCF3SO3 obtained with addition of plasticizer into SPE was 4.83 x 10-3 S.cm-1 at 50 wt.% EC in 62.3 mol% EMG30-LiCF3SO3. Ionic conductivity for all systems was also studied as a function of temperature from 303 K up to 373 K. The plot of log σ versus 1000/(T-To) for each sample obey VTF behavior. The ionic transference number of the SPE and GPE system studied was found to be ~0.83 and ~0.96, respectively. These results reveal that both systems were predominantly due to ions and only negligible contribution came from electron. The window stability of 62.3 mol% EMG30 based on SPE was observed around 1.8 V versus SS and 3.02 versus Li+/Li whereas the window stability of GPE was around 2.9 V versus SS and 4.5 V versus Li+/Li. The highest conducting of SPE and GPE were chosen as an electrolyte in electrochemical double layer capacitor (EDLC). EDLC containing GPE exhibits the most stable performance with higher specific capacitance value (0.470 F g-1) and can maintain its electrochemical stability over 100 cycles of charge and discharge processes. The highest power density (P) and energy density (E) were found to be 7.49 W kg-1 and 9.71 Wh kg-1.