Abstract No: 246 ***Physical Sciences***

COMPATIBILITY OF DIFFERENT ELECTROLYTES WITH CARBON-BASED ELECTRODES IN ELECTROCHEMICAL DOUBLE-LAYER CAPACITORS

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Supercapacitors are emerging as alternative energy storage devices against electrochemical cells due to their greater power density, short charging time and longer cycling ability. Electrochemical double-layer (EDL) capacitors consist of two electrodes separated by an electrolyte preferably with a liquid electrolyte. The capacitance arises from electrostatic charge separation as EDL at the interface between the electrode and liquid electrolyte. In this investigation, the compatibility of liquid electrolytes was studied with three types of carbon electrodes in EDL capacitors. Sri Lankan natural graphite, commercially available activated carbon and graphene were used as carbon materials. Electrodes were prepared by applying a slurry containing a mixture of 80 wt% of one of the above carbon materials, 15 wt% polyvinylidenedenefluoride and 5 wt% carbon black powder in tetrahydrofuran (THF) on thin foil of aluminum. Lithium chloride dissolved in distilled water was used as an aqueous electrolyte and lithium perchlorate dissolved in THF was used as the non-aqueous electrolyte. A gel polymer electrolyte was prepared by dissolving appropriate amounts of polyethylene oxide and lithium perchlorate in THF. Fabricated EDL capacitors were characterized by complex impedance spectroscopy and cyclic voltammetry. The galvanostatic charge-discharge measurements were carried out using LoggerPro 3.6.1 instrument. A single conductivity mechanism could be verified from the smooth semicircular section of impedance plots, and the linear portion confirmed the non-reacting nature of materials at the interface. Cyclic voltammograms verified the chemical stability of the cell within the charge-discharge limits of ± 1.0 V for aqueous solution and ± 2.0 V for non-aqueous electrolytes. The graphene electrode with aqueous LiCl showed ionic conductivity of 0.22 S cm^{-1} and capacitance value of 0.446 F for potential between ± 1.00 V, and 0.25 F for potential between ± 2.00 V for non-aqueous electrolyte. From the experimental results, it can be concluded that graphene, having highest surface area, is suitable for stable high capacitance with better compatibility of the systems studied.

Keywords: Carbon-based electrode, Electric double-layer, Gel polymer electrolyte, Interfacial compatibility, Supercapacitors