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Silver-modified carbon material and its application in supercapacitor devices

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INTRODUCTION

Nowadays, supercapacitors are widely investigated due to their interesting characteristics in terms of power and energy density. These kinds of devices offer an exciting and technologically interesting compromise with respect to power density (greater than batteries) and energy density (greater than conventional capacitors) [1]. The configuration of a supercapacitor device is as simple as conventional capacitors. An electrolyte (liquid/solid/gel) is sandwiched between two electroactive electrodes to fabricate a supercapacitor cell. On the basis of the types of electrode materials used and the charge storage mechanism, it is classified into two types; (a) electrochemical double layer capacitors (EDLCs) in which large surface area carbonaceous types of materials are used and the charge storage mechanism is electrostatic in nature; and (b) pseudocapacitors, in which conducting polymers and electroactive oxides are used and fast faradic charge transfer reaction gives rise to pseudocapacitance [2-3]. In the present work, activated carbon has been modified on the surface by using silver metal and the synthesized material has been tested for supercapacitor application using gel polymer electrolyte (GPE).

EXPERIMENTAL

For electrolyte preparation, gel polymer electrolyte film, PVdF-HFP-PC-$Mg(ClO_4)_2$ has been prepared by using standard solution cast technique. For electrode preparation, 90% AC@Ag of active material was mixed with 10% of PVDF binder dispersed in small amount of acetone solvent. After that, a required amount of the slurry was coated on carbon cloth material. Finally, the coated electrodes were dried overnight at room temperature. Symmetrical EDLCs have been fabricated by sandwiching GPE in between activated carbon electrodes.

RESULTS AND DISCUSSION

The GPE shows the highest ionic conductivity of the order of 5.0 x 10^{-3} S cm^{-1} at room temperature. The detailed electrochemical and electrical studies are discussed elsewhere [3]. The SEM-EDX analysis confirms the presence of silver particles. Performance of EDLCs have been tested by using impedance spectroscopy, cyclic voltammetry and charge discharge techniques. Fig 1 shows the typical impedance spectroscopic curve of EDLC cell at 1.0 mHz. As can be seen from the curve small semicircle in the higher frequency range followed by a steep rising portion towards lower frequency range confirms the typical EDLC behavior. The values of bulk resistance R_b, charge transfer resistance R_{ct}, overall resistance R are found to be of the order of 42.4, 4.2 and 600 Ω cm^2. The overall capacitance value of the EDLC cell is 279.2 mF cm^{-2} which is equivalent to single electrode capacitance of 180 F g^{-1}.

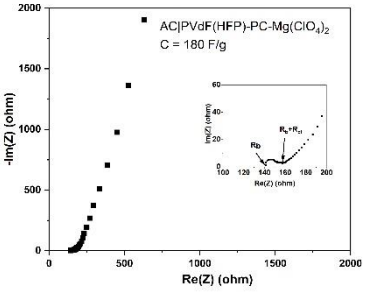

Fig 1. Impedance plot

CONCLUSION

From the present studies, it can be concluded that silver modified AC was suitable for supercapacitor application with Mg ion based gel polymer electrolyte. The overall capacitance value of 279.2 mF cm^{-2} has been achieved, the EDLC cell shows very less charge transfer resistance.

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