Graphene Enhanced Carbon Electrode For Supercapacitor

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Abstract- *This paper provides the analytical study and details about a new wonderful material called graphene, to be used in Supercapacitors. Graphene has a 2-dimensional (2D) network structure with very good electronic, chemical and mechanical properties. Supercapacitors are the future of smart technology. It can full fill the energy demand in portable electronic devices, for that purpose we need a very high density energy storage in supercapacitors, which is not possible with traditional materials but with the use of graphene electrodes in the supercapacitors the charge density in supercapacitors can greatly improve.*

Keywords- graphene; supercapacitors; graphene oxide(GO); carbon electrodes; reduced graphene

I. INTRODUCTION

The use of graphene in the supercapacitor provides very high density energy storage and very high rate of charging/discharging. Supercapacitors are an innovative idea to power the smart electronic wearable devices. Supercapacitors are based on the electrostatically (Double layer capacitor) or electrochemically (Pseudocapacitors) charge storage technology. They have potential to fulfill the future energy storage demand in electronic devices. The surface to mass ratio of graphene is very high, this provide a very light weight option for the nano energy storage units like supercapacitors.

The main parameter for a supercapacitor is Energy and Power. When we compare the graphene based supercapacitors with aluminum electrolytic capacitor we found that energy density in graphene supercapacitor is more [1-3]. The graphene based supercapacitor also posse's ultra high power density about ~1230mW/cm3. The supercapacitor having two electrodes and an electrolyte solvent, when we make an comparison between conventional charge storage techniques, the supercapacitors posses very high electrode active part[4-6]. The thermal conductivity of supercapacitor is excellent. The most of supercapacitors used activated carbon for the electrode material. For this the graphene material can offer a a very high surface area about~2360m2/g. working of supercapacitors are basically the surface phenomenon [7,8]. Graphene which is used in supercapacitors with super thin thickness, having a large surface area, which helps it to become the ideal active material for supercapacitors. Laser reduced graphene supercapacitors have excellent electrochemical performance [9]. Electrode material plays a very important role to decide the performance of the supercapacitors, by using the appropriate electrode material (electrode material with higher specific capacitance) we can improve the performance of supercapacitors [10].

II. DESIGN

The design of supercapacitor consist a no. of thin layers with following parts- electrodes (Graphene oxide), metallic contactors, electrolyte material and a electrically separator film. All these forms a sandwich like structure with two terminals as showing in Fig-1

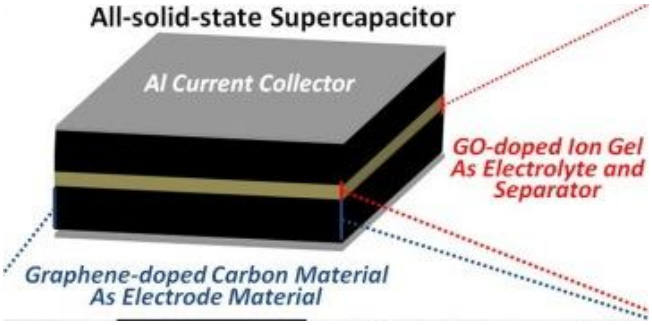

Fig-1 GO electrodes based thin film supercapacitor

Electrolyte material is polymer material and an ionic liquid.

III. MATERIAL

Graphene Oxide (GO)-Based Electrode

A simple setup with two grahene oxide based electrode configuration was used to fabricate the supercaacitor. Graphene oxide (GO) is used as the basic electrode material.

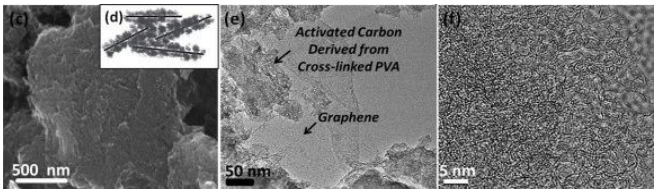

Fig-2 GO electrode photo

The modified Hummer's method is used. The first step is starting from the graphite powder (size > 50µm). At first, the Graphite was oxidized into graphene oxide or GO by the help of oxidants like H2SO4 , KMnO4 and H2O2. This reaction introduces some functional group containing the oxygen into graphene structure and form graphene oxide, that can further reduced into the form known as Reduced Graphene Oxide (rGO).

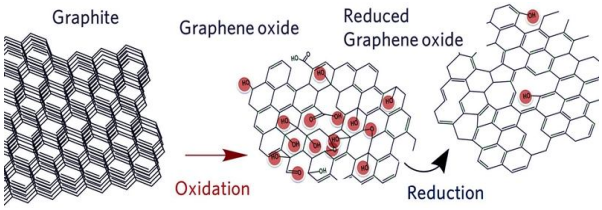

Fig-3 Synthesis flow of graphene

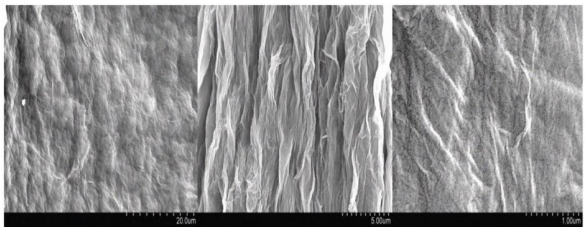
Fig-4 SEM images of graphene electrode surface

IV. FABRICATION

The fabrication process of the graphene oxide based supercapacitors is given as follows- first the bottom metallic layer for conduction is formed by metal evaporation process. SiO2 layer is used for insulation purpose. A coating of GO slurry was sprayed on the electrode layer, thus the graphene oxide is fabricated on electrode. After that we provide heat to the electrode that make it solid electrode. Another electrode can be formed with the same process. Electrolyte thin film introduces by spreading a gel type mixture between electrodes. Thus a super capacitor is fabricated.

V. CONCLUSION

In our paper, we conclude that Graphene as an active material is extremely ideal material for the supercapacitors. The reduced graphene oxide(rGO) greatly improve the charge density for supercapacitors, in addition it also provide the fast rate of charging and discharging and long life cycle.

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