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Investigation of Carbon Material Derived From Leaves of Tree for the Electrodes of Supercapacitor

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Abstract: *Supercapacitor or ultra capacitor also known as electric double layer capacitor consists of two electrodes, which are mechanically separated by a separator and electrically connected to each other via electrolyte. The mechanism of charge storage is provided by electrode materials while electrolytes provides conducting medium for them. For the electrodes of supercapacitors, different types of materials are used but activated carbons were the first material selected for supercapacitor electrodes. The nature of Electrode materials for supercapacitor are symmetric i.e. both electrodes have similar material. In recent times, due to their applications in pulsing techniques, digital device, electrical vehicles etc supercapacitors are gaining more popularity. The focus of this research work is to synthesise active carbon by using dead leaves and compare with the available active carbon.*

Keywords: *carbon , electrodes, electrolytes, supercapacitor*

1. INTRODUCTION

Big cities face the problem of waste management. For separating dry and waste materials, several environmental communities are taking initiative. These waste materials contain carbon as well as other component in various ratios depending upon the type of waste. Hazardous gaseous and ash are produced by burning waste material. By harnessing natural and some of the manmade waste, electronically active carbon can be synthesized, from which one can get valuable products for various carbon based applications.

Carbon with different applications [1]-[6] exhibit in a variety of molecular and structural form such as diamond, amorphous carbon, graphite, nanotubes, fullerene, porous carbon, graphene etc. Among them graphene and porous carbon have high surface area and is chemically inert. These properties make them efficient to be used in supercapacitor and batteries [7]-[9]. Lots of research is going on supercapacitor due to its properties like high durability, high power density and fast charging and discharging mechanism [10]-[12]. Also they have wide range of application in electric vehicles, digital device, pulsating techniques etc.

To obtained high quality carbon, scientists have tried various synthetic routes which include vapour deposition [4], carbonization of organic precursors [3], arc discharge synthesis chemical; [5], chemical methods, etc. More recently for the synthesis of carbon for charge storage applications, they are focussing on organic waste materials.

Supercapacitor or ultracapacitor [2]-[11] also known as electric double layer capacitor consists of two electrodes immersed in an electrolyte solution. Charge storage mechanism is provided by electrodes while electrolyte provide conducting medium for them. The cell structure of supercapacitor is symmetric in nature i.e. Both electrodes have same materials. Supercapacitor offers very high capacitance per gram of material than conventional capacitor.

In this research work, carbon materials is synthesise by using plant leaves and compare it with Vulcun XC-72 for super capacitor applications. Here, the detailed study is done on neem leaves but it can be applicable to other types of leaves also.

2. Experiment and Analysis

Neem leaves were collected from Bharati Vidyapeeth campus in large quantity and it is thoroughly washed and kept in an oven at 80°C for drying purpose. These leaves were crushed with the help of mixer to get fine powder and stored in a dry atmosphere. To synthesise active carbon, 15gram of powder neem leaves was heated in a porcelain container at 300°C for 5 hours in a nitrogen environment. After keeping the sample in muffle furnace, temperature is increased at a rate of 10°C per minute. After attaining 300°C, kept the sample for 5 hours continuously. After heating for 5 hours, colour of neem leaves powder gets changed from light green to black colour carbon. These samples were collected and through washed with 3M sulphuric acid solution. After washing with acid, sample were filtered and is kept in oven for half an hour at 100°C for drying purpose. After drying, samples were crushed in to fine powder by using mortar pestle. Similar trails were taken at 600°C, 800°C,1000°C for 5hours [13]. For loading on wire mesh, these neem leaves derived carbon are mixed with 20% Vulcun XC-72.

For developing one prototype, two wire mesh SS316 of dimension 3cm X 1cm are taken. A paste of neem leaves derived carbon (80%) and Vulcun XC-72 (20%) with isopropyl are formed and a loading of 20mg/cm is applied on the wire mesh. After loading, wire mesh is kept in front of dryer for 5min for drying purpose. After drying, wire mesh is sandwich in between three separators with the help of hardener and araldite paste which is used as a adhesive. Another prototype was developed only by using Vulcun XC-72 active carbon and it is compared with previously developed prototype on the basis of specific capacitance, area based capacitance, internal resistance, and energy density and power density values. For both prototypes, electrolyte used is potassium sulphate because it got higher potential voltage.

Table1. *Comparison of Supercapacitor made up of Neem leaves derived carbon and Vulcun XC-72 activated carbon.*

Parameters	Vulcun XC-72	Neem derived carbon
Pulse current mA	32.43 mA	31.10 mA
Capacitance F/cm^2	0.04 F/cm^2	0.022 F/cm^2
Capacitance F/gm	0.5 F/gm	0.28 F/gm
Energy density Wh/gm	1.20 Wh/gm	0.66 Wh/gm
Power density Kw/gm	0.122 Kw/gm	0.156 kW/gm
Internal resistance Ω	41.5 Ω	32.30 Ω

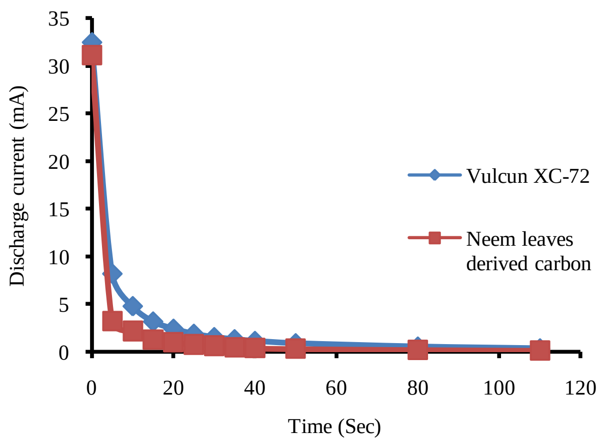

Figure 1. *Supercapacitor discharge current characteristics for different carbon based materials.*

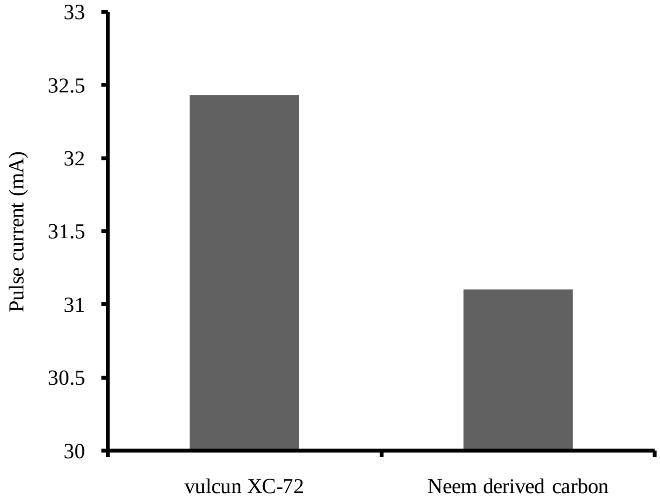

Figure 2. *Pulse current characteristics for different carbon based materials.*

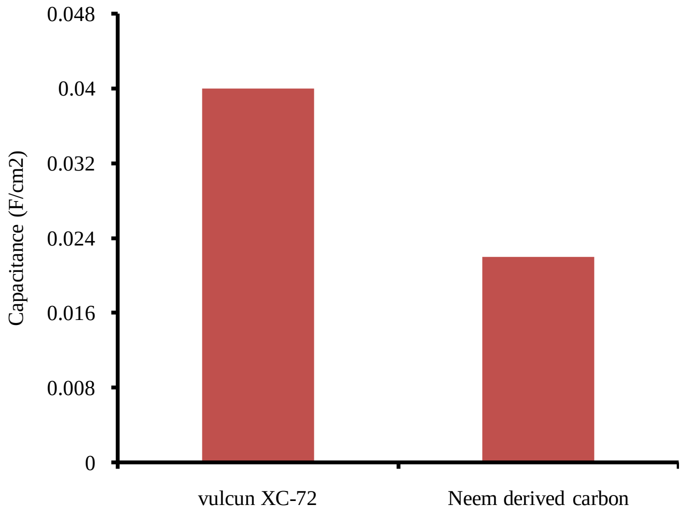

Figure 3. *Area based capacitance of supercapacitor for different carbon based materials*

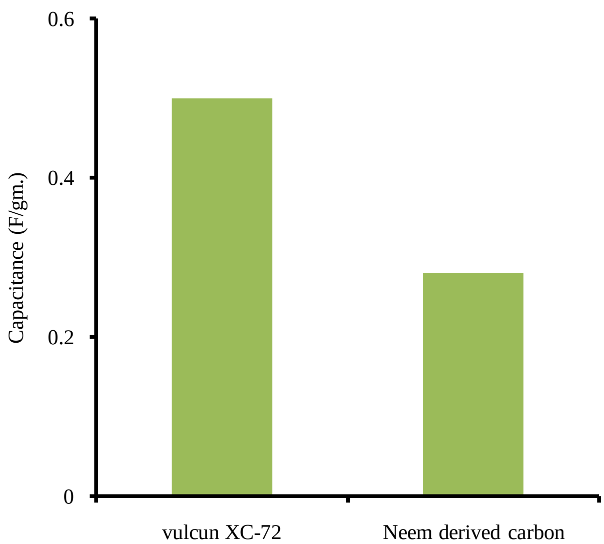

Figure 4. *Specific capacitance of supercapacitor for different carbon based materials*

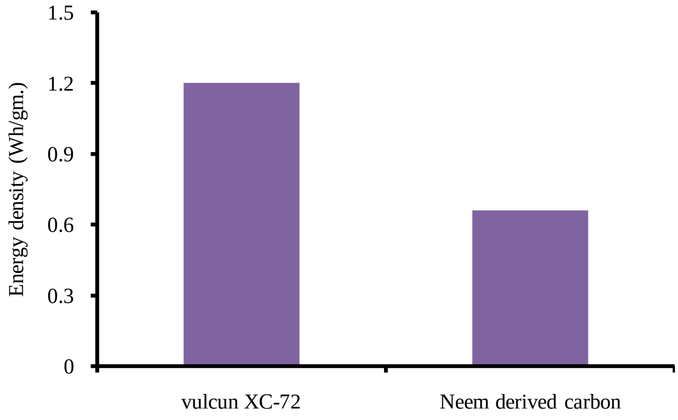

Figure 5. *Energy density of supercapacitor for different carbon based materials*

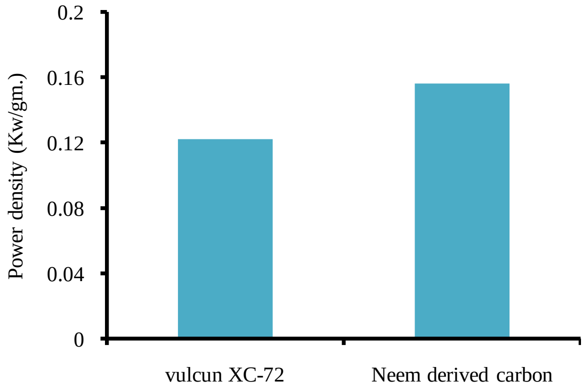

Figure 6. *Power density of supercapacitor for different carbon based materials*

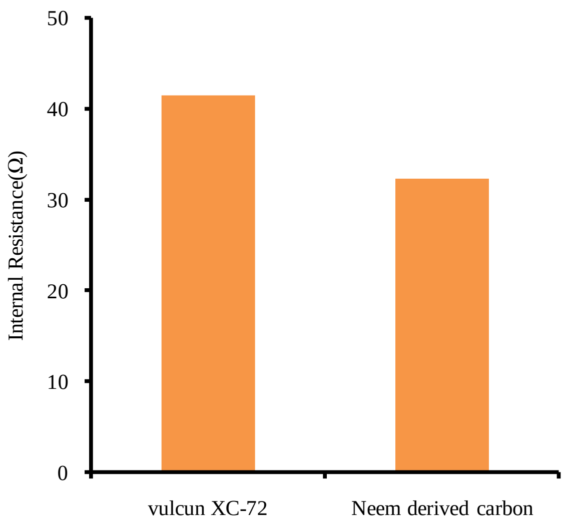

Figure7. *Internal resistance of supercapacitor for different carbon based materials*

3. CONCLUSION

Different characteristics of supercapacitor derived from neem leaves are studied and is compared with Vulcun XC-72. After studying it is observed that, neem derived carbon has high power density values and low internal resistance value as compared to Vulcun XC-72 supercapacitor. But, it has low pulse current and specific capacitance value with respect to Vulcun XC-72. Performance of neem derived carbon can be further improved and even more better than Vulcun XC-72 if it is heated at high temperature above 600°C strictly under the Vacuum. Also, trails are going on by varying percentages of Vulcun in leaves of derived carbon. However, deriving carbon from leaves is cost effective and also environmental friendly.

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