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Fabrication of Flexible Electrodes for supercapacitor using Bio-Degradable material

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Abstract— **This paper a electrode material, was obtained by the thermal decomposition of biodegradable waste. A lab-scale supercapacitor (SC) was fabricated using as-prepared electrode and supercapacitive behaviour was investigated using techniques like Cyclic Voltametry (CV), Electrochemical impedance Spectroscopy (EIS) studies.Each of electrode showed a specific capacitance and the constant charging/discharging current densities. We are observing the EIS and CV studies, and graphs are observed. This remarkable supercapacitive performance of biological waste-derived electrode will be demonstrated as potential as a cost effective and environmentally friendly electrode material for aqueous electrolyte-based SCs. With a constant 0.1 Ag-1 charging/discharging current density, each electrode of the coriander char demonstrated a unique capacitance of 91.73 Fg-1.whereas the menthol mint char displayed a unique capacitance of 79.03 Fg-1.Moreover, the total weight of the cell arrangement s 16.4 mg and 17.7 mg, respectively.The coriander char and menthol mint char derived from biological waste have the potential to be a low-cost and environmentally friendly type of electrode material for aqueous electrolyte gel due to their exceptional capacitive performance.**

Keywords— Char Coal, Biological waste, Aqueous electrolyte.

I. INTRODUCTION

In current scenario, Energy is a vital subject since energy supplies are crucial for both domestic and commercial purposes .[1]Development and commercialization of ecologically acceptable renewable energy sources, as well as the accompanying technologies, are thus of utmost importance.[1] SCs are more significant than other contemporary gadgets that store energy because of their greater power density storage capabilities as well as their many advantages, such as their high-power density, prolonged lifespan, the ability to operate over a broad range of temperatures, excellent performance, and specific capacitance range.[1] SCs are also applicable in a variety of settings, including electric grid, rail, electric vehicles, solar generating, and wind power generation. They are frequently used as power supply for portable electronics such laptop computers, phones, digital cameras, and other similar items since they are portable and lightweight. In electric and hybrid automobiles, SCs may offer the quick period of high-frequency charging discharge (dynamic operation), shielding batteries from it, and the high-power density required for short-term acceleration as well as energy recovery during braking.[1] Energy storage devices like supercapacitors (SCs) are well known for their high specific power, exceptional charge-discharge capability and long life [2]. Types of SCs include electric double- layer capacitors (EDLCs), pseudocapacitors and hybrid SCs. EDLCs store charge in the electro-chemical double layer (EDL) and are familiar for their prolonged cycle life and outstanding charge-discharge capabilities [3]. Activated carbon (AC), carbon black, graphene and carbon nanotubes (CNTs) are the most abundant electrode materials for EDLCs [4], and most of the commercially available EDLCs use AC as electrode material [5]. Recent advances in SC research were focused on exploring new resources for electrode materials that are economically feasible, abundant and derived from renewable precursors. Therefore, extensive research was directed toward deriving carbons from biological wastes for application as electrode materials in SCs [1]. Carbons derived from sugar cane bagasse [6], bamboo [7], straw of rice [8] and wheat [9], stems of sunflower [10] and lotus [11], stalks of corn [12] and cotton [13] were already applied in SCs as electrode materials. Natural fibers obtained from bamboo [14], jute [15] and hemp [16] and leaves of pine [17], lotus [18], Ficus religiosa [19] and eucalyptus [20] were also utilized to derive carbon-based electrode materials for SC application. Seed shells like coconut shells [21], macadamia nut shells [22] and oil palm kernel shells [23] were also used to derive carbons and tested as electrode materials in SCs. Menthol mint and coriander are the major food resources in the Andhra Pradesh .With a total area of 3.4 lakh hectares and an output of 2.23 lakh metric tonnes, the crop is planted in practically all states. [24], and per annum, around 759.6 million tons of plant leaves is cultivated, The main constituents of menthol mint and the coriander leaves are cellulose, lignin, silica (SiO_2) and moisture [28,29]. Firstly, menthol mint and the corriender leaves are carbonized and later, the carbonized menthol mint and the corriender leaves are activated using activating agents like KOH [31], NaOH [32], H_3PO_4 [33] and $ZnCl_2$ [34], to obtain porous carbons. The use of such chemical agents consumes a major portion of the production cost and the release of chemical effluents causes harm to the environment, making these methods very expensive and not eco-friendly [36]. In the present work, menthol mint and the corriender leaves char, was derived by thermal decomposition activation, making the process simple, cost-effective and eco-friendly. The physicochemical properties of menthol mint and the corriender leaves were investigated. A lab-scale symmetric SC was fabricated using menthol mint and the corriender leaves as electrode material, hydrothermally reduced carbon cloth (CCHy) as current collectors and graphene-based nanocomposite gel

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polymer electrolyte (NGPE). The supercapacitive behaviour of menthol mint and the corriender leaves in the EDLCs configuration was evaluated using techniques like cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS) to determine the practicality of menthol mint and the corriender leaves as a potential biological waste derived carbon-based electrode material for SCs.

The organization of this paper, The section-II, discuss about the device architecture and its dimensions. The section-III, discuss about the device simulations and extracted the device performance parameters and conclusions presented in section-IV.

II. PROPOSED DEVICE ARCHITECTURE

Fig.1 shows the schematic structure view of biodegradable electrode materials of the flexible supercapacitor cells.In this the below figure represents the step by step process for the fabrication of the biodegradable electrode material for supercapacitor. In this we follows the 2*1 ration of the cell size.

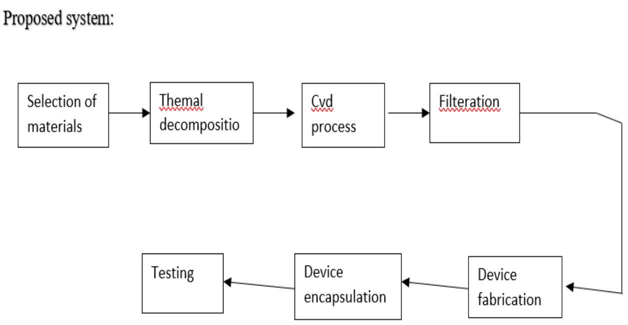

Fig. 1. The process flow of the flexible electrode cell of biodegradable materials.

III. RESULTS AND DISCUSSIONS

Cell studies:

Using the CV, GCD, and EIS experiments, the super capacitor behaviours of coriander and menthol mint are observed. The various scan rates are illustrated in the figures above, demonstrating the improved capacitive behaviour with high reversibility and rate probability. The specific power Ps, specific capacitance CS, specific energy, and the specific power Cp of the symmetrically based coriander and the menthol mint were observed and computed. The figures show the constant current densities Ag-1.

When I, v, t, and m stand for the constant current, discharge time, discharge voltage, and mass of coriander (16.4) and the menthol mint (17.7) on both electrodes, respectively, the equations are:

$$C_s = 2\,\frac{I\Delta t}{m\Delta V}$$

$$E_s = Cs\Delta V^2/8$$

$$Ps = Es/\Delta t.$$

Coriander has the highest specific capacitance, with a value of 91.463 Fg-1, according to the afore mentioned graphs. 5 mA of current density. Ps = 0.548 KW Kg-1, so. also, a 11.43 Wh Kg-1 Es. The experimental findings from the GCD investigations on coriander and menthol mint are shown in the tables below. Whereas the table shows the contrast between various capacitive performance flowers made of carbon-based materials.

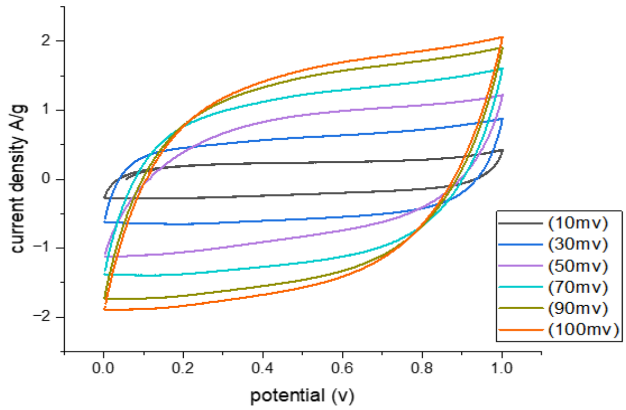

Fig -5.1: CV graph of coriander.

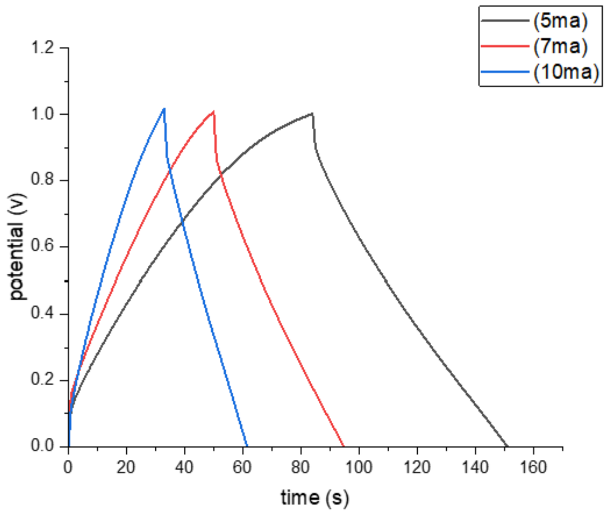

Fig -5.2: GCD graph of coriander.

Coriander leaves studies of GCD:

Current density, Ag^{-1}	Discharge time, s	Specific capacitance, Fg^{-1}
5ma	75	91.463
7ma	47.5	81.09
10ma	30	73.17

Table- 01: Coriander leaves of GCD studies

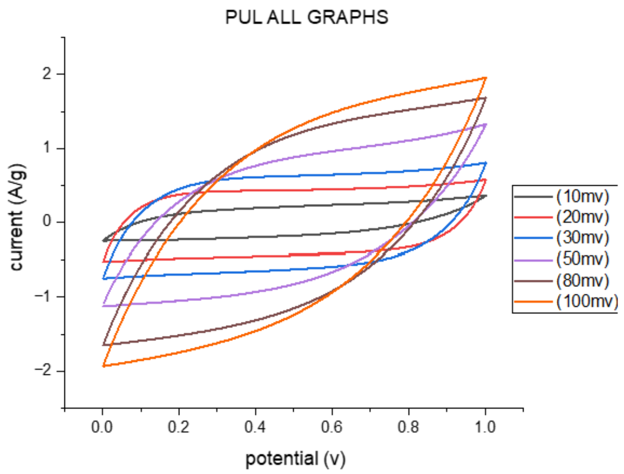

FIG-5.6: CV OF MENTHOL MINT

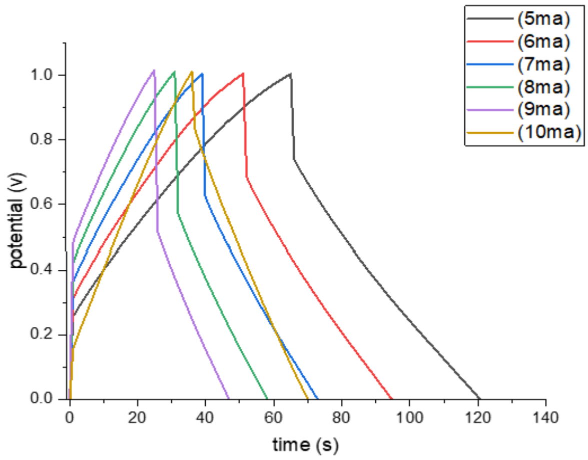

Fig -5.5: GCD OF MENTHOL MINT

Menthol mint studies:

Current density, Ag^{-1}	Discharge time, s	Specific capacitance, Fg^{-1}
10ma	35	79.09
5ma	60	67.79
6ma	47.5	64.4
7ma	37.5	59.32
8ma	27.5	49.71
9ma	22.5	45.76

Table-02: Menthol mint studies of GCD

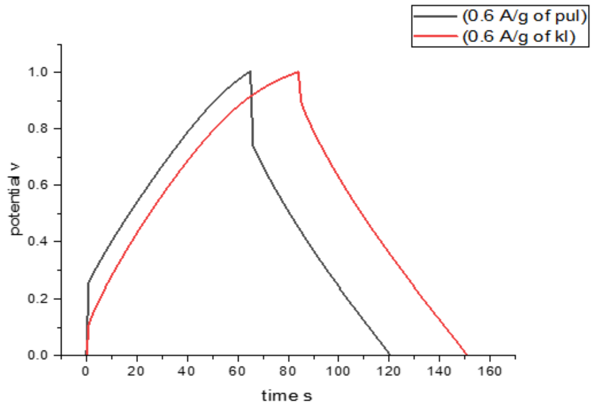

FIG -5.9: comparison of coriander and the menthol mint.

From the above diagrams and the graphs, we conclude that the coriander is having the more specific capacitance and the more conductivity. The above graphs of figs 29 and 30 are compared of the 5A/g of the current densities. And in the GCD and the CV graphs the coriander is having the discharge current of 135 and where as the menthol mint is having the discharge current of 60s and the CV graphs are taken at the 100 mv.

IV. CONCLUSIONS

In this paper, Coriander and the menthol mint were thermally decomposed to produce coriander char, which were analysed using physicochemical methods. By building a lab-scale SC and analysing its super capacitive performance using electrochemical methods including CV, GCD, and EIS, the viability and application of coriander and the menthol mint as prospective electrode materials in EDLCs were assessed. Coriander and the menthol mint on each electrode of a full-cell (2-electrode) design displayed specific capacitances of 91.463 F g-1 at 0.1 A g-1 and 79.09 F g-1 at 0.1 Ag-1, increasing their effective surface areas and improving the super capacitive behaviour. And in this instance, the masses for both electrode materials, such as coriander and menthol mint, are 16.4 and 17.7 mg, respectively. The focus of recent research is on the potential of menthol and coriander as carbon-based electrode materials for SCs based on aqueous electrolytes.

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