



Synthesis and characterization of graphene oxide from locally mined graphite flakes and its supercapacitor applications



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ABSTRACT

Graphite is a mineral mined from different parts of the world which including Africa. It can be used or converted into different carbon materials such as exfoliated graphite, graphene, Graphene Oxide (GO), graphene nano platelets, carbon nano tubes, carbon onions among others by chemical or mechanical methods. The locally mined graphite flakes was converted to GO using chemical methods known as Hummer's oxidation method (HM). This method was also compared with other modified Hummer's methods by altering the conditions and the materials used. In the modified Hummer's method 1 (MHM1) a ratio of 9:1 of H₂SO₄/H₃PO₄ was used. While the modified Hummer's method 2 (MHM2) a reflux process was employed. The synthesized GO materials were characterized by different techniques such as UV-Vis spectroscopy, FTIR, SEM-EDX, XRD and electrochemical analysis. The morphology, functional groups, different bonds, elemental composition, crystallographic structure and energy storage applicability of the GO were examined. The techniques confirmed formation of functional groups like C-O, C=O and the C/O ratio in the materials. The electrochemical characterization performance of materials produced the highest specific capacitance of 211.2 F/g with a current density of 0.5 A/g and the specific energy of 7.33 Wh/kg.

1. Introduction

The science of design of nano materials involves different steps which include synthesis of the starting materials, characterization, optimisation, isolation exfoliation and cleaning. In the naturally occurring materials, carbon is the most abundant element in all organic substances on the universe. It occurs in many forms of different arrangements called allotropes of carbon with Africa as one of the continent with many mineral deposits like graphite among others. Its abundance makes it the main source of any form of carbon which include carbon black, graphene oxide, graphene, nanotubes, carbon onions, graphite, diamond to mention but a few [1]. Graphene oxide (GO) is in the category of graphite

which can be processed by oxidation and mechanical methods. The graphene and its oxidised state has gained a lot of interest by both industrial application and academic research in fixing the earth's challenges and demand of materials. This is because of their interesting different properties which include mechanical, electrical among others [2,3]. Different raw materials are used in the process of synthesis of graphene oxide. Particular, graphite flakes deposits which are present in Africa can be used as raw materials for the manufacture of materials such as Graphene oxide and other carbon materials like thermally expanded graphite used in fabrication for different application parts.

Graphene oxide (GO) can be synthesized chemically from graphite flakes. Graphene oxide in its structure contains different functional

Abbreviations: GO, Graphene Oxide; EC, Electrochemical; GCD, Galvanostatic Charge/Discharge; CV, Cyclic Voltammetry; EIS, Electrochemical Impedance Spectroscopy; HM, Hummer's method; MHM, modified Hummer's method; H₂SO₄, Sulphuric acid; NaNO₃, Sodium nitrate; KMnO₄, Potassium permanganate; H₂O₂, Hydrogen peroxide; HCl, Hydrochloric acid; UV-Vis, Ultra-Violet-Visible Spectroscopy; FTIR, Fourier Transform Infrared Spectroscopy; SEM, Scanning Electron Microscopy; EDX, Energy Dispersive X-ray; XRD, X-Ray Diffraction.

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