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Functionalized Graphene/Conducting Polymer Matrix as a Better Supercapacitor Material

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Abstract
Electrochemical Supercapacitors provide apositive answer to the market demand of high powerenergy-storage systems."Functionalization" of graphene is where a graphene sheet can be modified, by introducing different functionalities (through covalent or non-covalent interactions), so utilise its chemical properties in a much better way. Holding the thought, we have synthesized Functionalized-RGO (FRGO) by treating RGO (Reduced Graphene Oxide) with H_2SO_4-HNO_3 for 24h. The obtained FRGO showed better capacitance in comparison to RGO. Further, incorporation of FRGO into PEDOT:PSS matrix showed more enhancement in conductivity as well as capacitive behaviourand electrochemical behaviourof the composite.
Keywords: Supercapacitor, Graphene, Functionalized Graphene

INTRODUCTION:

Graphene is an allotrope of Carbon (like CNT, diamond and graphite) with one-atom-thick planar sheets of sp^2-bonded carbon atoms that are densely packed in a honeycomb crystal lattice and was first isolated as a "single-atomic" sheet in 2010[1].Improving the high-performance energy storage problems,utilizing the electrochemical applications of graphene, has been a widespread excitement among scientists due to its exceptional physical attributes. Having considered graphene's inimitable electrochemical, physical properties and its subtle electronic characteristics compared to other possible electrode materials, suggest a potential future in energy production and storage as supercapacitors as well as inLi-ion storage battery, solar power devices etc[2].On the other hand, because of their unique physical properties and versatile application potential, conducting polymers (CPs) have attracted a lot of scientific and technological interest[3]. Due to their light weight, low cost and easy processability, conductive polymer composites (CPCs) are attractive materials for electronic device application areas viz. batteries, light emitting diodes, photovoltaic cell, EMI shielding materials, chemical and biosensors, electrochromic displays, electromechanical actuators etc[3]. From past few years, researchers have been working widely in the field of graphene/CPs based composites for the supercapacitor as well as sensing applications, utilizing the properties of both graphene and CPs[4-8]. Graphene engineering is "functionalization" of graphene, where a graphene sheet can be modified, by introducing different functionalities (through covalent or non-covalent interactions), to utilise its chemical properties in a much better way[9,10].

Keeping this in mind, we have synthesized Functionalized-RGO (FRGO) by treating RGO (Reduced Graphene Oxide) with H_2SO_4-HNO_3 for 24h. The obtained FRGO showed better capacitance in comparison to RGO. Further, incorporation of FRGO into PEDOT:PSS matrix showed an enhancement in conductivity as well as capacitive behaviour of the composite.

Synthesis and Characterization

Graphene sheets were synthesized using Hummer's Method (using $KMnO_4$ in the presence of Sulphuric and Phosphoric acid) from Graphite powder. Graphene Oxide (GO) was washed and treated with mixed acid (3:1 H_2SO_4/HNO_3) for 24 hours at 50°C. The acid-treated GO was separated and washed properly with distilled water. Functionalized GO was then reduced using Hydrazine at 95°C for 12 hours, to get Functionalized Reduced Graphene Oxide sheets (FRGO). FRGO and RGO sheets were incorporated with PEDOT:PSS matrix

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