GRAPHENE-COATED PYROLYTIC CARBON FROM TEXTILES

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1 General Introduction

Recently, great interest has been focused on graphene nanocomposites for various applications. Graphene is a one atom-thick material made up of sp^2-bonded carbon atoms. Its unique properties include high electrical and thermal conductivity, the quantum Hall effect, massless transportation properties, and strong mechanical properties . Among several possible applications, the use of graphene as an electrode in lithium batteries is very promising because of graphene's relatively low-cost and accessibility. However, a graphene anode alone provides relatively low lithium storage capacity and has an unstable charge and discharge cycle performance, which is a problem to overcome before the commercialization of graphene electrodes is feasible. Recently, several different nanomaterials, including various carbonaceous materials and nanometal/oxides has been tested as templates to enhance the lithium storage capacity and the cycling performance of the graphene. However, because of the high cost, inaccessibility, and the potential nano-toxicity of these template materials, it has proved difficult to produce graphene-based electrode materials on a large scale.

Cotton is almost pure cellulose. It is a carbon-rich, cheap, and available on a large scale. Recently, it has been reported that highly electro-conductive cotton/carbon nanotube composites can be simply prepared by dipping a cotton fleece (pile) fabric in a carbon nanotube solution. This was successful because of the flexibility of the nanotubes and the strong binding between the carbon nanotubes and the cotton fibers. Graphene also exhibits the good flexibility and electro-conductivity that carbon nanotube do, but with the added advantage of being potentially much less expensive.

However, little research has been done on the fabrication of graphene-coated textiles, probably due to the difficulty of preparing stable graphene solutions, wrapping the seamless graphene layer on the fibers, and reaggregation of graphene sheets, as well as the complications of pre- and post-treatments. Pyrene molecules can not only act as nano-graphene molecules to heal possible defects in the graphene oxides, but can function as electrical ''glue'', soldering adjacent graphene sheets during the annealing process. In addition, previous research has shown that a simple and scalable exfoliation approach to produce high-quality graphene suspensions can be achieved by sonicating graphite in an aqueous solution of hydrophilic pyrene molecules. In the present work, we use cotton fibers as templates where the graphene sheets are created and wrapped the fibers. This is done by emersing cotton fabric in a graphene suspension and "soldering" with the nanographene (pyrene derivative) after annealing. The result is a graphene-coated pyrolytic carbon material. Here, the pyrene derivative plays a double role in the preparation of the material. In the graphene suspension, the pyrene derivative acts as a surfactant to disperse, stabilize and separate the graphene from each other; in the annealing process, it acts as a "glue" to heal defects and bridge the gap between graphene sheets. Because of the core-shell structure of the graphene-coated pyrolytic carbon, we believe that the graphene-coated pyrolytic carbon can exhibit excellent charge/discharge performance, as well as mechanical flexibility.

In the present work, the chemical nature, morphology, and thermal and electrical properties of the graphene-coated textile nanocomposites have been studied by atomic force microscopy (AFM), UV-Vis spectroscopy, scanning electron microscopy

(SEM), energy-dispersive X-ray spectroscopy (EDS) and Galvanostatic charge-discharge experiments. The primary goal of this work is to produce a facile, low-cost method to prepare graphene-coated pyrolytic carbon materials for potential applications in energy-storage, electronics, consumer-wearable applications, and even perhaps in water treatment.