شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

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HANAA ALY

PREPARATION OF HIGH QUALITY GRAPHENE BY A PHYSICAL METHOD

By

Muhammad Adel Abdel Ghafour El-Damanhoury

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the degree of

INTERDISCIPLINARY - MASTER OF SCIENCE
In
Advanced Materials and Nano-Materials

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

PREPARATION OF HIGH QUALITY GRAPHENE BY A PHYSICAL METHOD

Key Words:

Graphene, Supercritical, Sonication, Quality, Yield

Summary:

A simple and cost-effective method is used for producing single- to few-layer graphene with high quality and high yield. This physical method utilizes supercritical CO_2 and ultrasonication energy. The resultant pure graphene can be used in many applications such as batteries, supercapacitors, composites and sensors.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

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Signature:

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Abstract

Graphene, the 2-D material that possess remarkable electronic, mechanical, thermal and optical properties, can be exploited to resolve many issues and overcome many challenges in different fields such as electronics, energy storage and harvesting, functional inks, composites, medicine, construction and many others. However, the production of high quality graphene with high yield and cost-effective method is a major challenge.

This work introduces a prototype of a system that can be used for high yield production of high quality graphene by a simple physical method that utilizes supercritical carbon dioxide (CO_2) and ultrasonic energy. Because of this cost-effective method, this prototype can be scaled up for mass production which leads to significant reduction in the price of high quality graphene. The resultant pure graphene can be used in many applications such as batteries, supercapacitors, composites and sensors.

The method of production involves loading a pressure vessel with graphite, and then pressurize it with carbon dioxide (CO_2) while heating until the pressure and temperature reach the supercritical point of the CO_2 or beyond. Next, running the sonication for a preset time before venting the product into dry empty container. The final product is graphene flakes.

The degree of exfoliation, number of layers and quality of the produced graphene was inspected by Atomic Force Microscope (AFM), Raman spectroscopy, fourier-transform infrared spectroscopy (FT-IR), Brunauer-Emmett-Teller (BET) specific surface area measurement, four-point probe resistivity measurements and transmission electron microscopy (TEM). The results demonstrated that the method used in this work can be utilized to produce high quality few- to multi-layer graphene with high yield in relatively short time considering the size of the prototype. The production rate can be largely increased with scaling-up the prototype to a mass production system