CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Cameron C. Jones

Project Number

S0910

Project Title

Laser Etching of Graphene Oxide to Create High Energy Density Micro-Supercapacitors

Abstract

Objectives/Goals

The purpose of my project was to create high energy density graphene-based supercapacitors that are highly compact and useful for powering small electronic devices. In today's world where phones and other electronic devices are getting even thinner, electronics have to accommodate ever-smaller form factors. To solve this, capacitors need to have a very high energy density. In this project, I aimed to demonstrate that it was possible to produce very thin supercapacitors using techniques that lend themselves to mass production.

Methods/Materials

To build the supercapacitors I drop-casted a diluted aqueous solution of graphene-oxide onto a polyethylene terephthalate (PET) substrate attached to a DVD disk and let it dry. Then, I utilized a LightScribe(R) DVD drive to etch interlocking electrodes into the graphene oxide. The laser from the DVD drive boils off the oxygen atoms from the graphene-oxide film leaving a 3D-form of highly conductive graphene in its place. I was able to etch complex electrode patterns into the graphene-oxide film. I used a gelled electrolyte made from water, polyvinyl alcohol (PVA) powder, and 85% concentration phosphoric acid. This was deposited in liquid form onto the electrode array and allowed it to dry.

Results

The supercapacitor devices that I built exceeded the capacitance/volume of traditional electrolytic capacitors. My supercapacitors had capacitance/cm^3 between 50x and 560x commercial capacitors. The supercapacitors were limited to voltages of approximately 2V due to limitations of the gelled electrolyte and the insulating graphene-oxide barrier. With my devices I was able to achieve capacitance per unit volume of up to 5,900 µF/cm^3.

Conclusions/Discussion

For this project, I was able to successfully produce functional high-energy density supercapacitors using simple fabrication techniques in my garage. Due to the extremely slim form-factor of these supercapacitors, they are well suited to be used in a variety of modern electronic devices such as phones, laptops, and tablets.

Summary Statement

My project is about designing and building high energy density micro-supercapacitors from laser-etched graphene oxide.

Help Received

None, except for help in purchasing materials necessary for the project.