2016 年臺灣國際科學展覽會
優勝作品專輯

作品編號　**200008**

參展科別　環境工程科

作品名稱　**Beets Revolution**

得獎獎項　一等獎

國　　家　**Hong Kong**

就讀學校　**The Chinese Foundation Secondary School**

作者姓名　**Chan Nai To**

Abstract

There is currently an interest in developing supercapacitors as the booming of smartphones and other mobile electric devices. Despite offering key performance advantages, many capacitors pose significant environmental hazards once disposed. They often contain fluorine, sulfur, toxic transition metal and cyanide groups, which are harmful if discarded by using conventional landfill or incineration methods. The objective of this project is to find an environmentally benign alternative for building various key components of supercapacitors structures. From the electrolyte, carbon substrate and materials corresponding for Faradic reaction, all the materials were devised from renewable biomass.

In our research, two novel designs of betanin/sulfonated carbon supercapacitor and quinone/sulfonated carbon supercapacitor were invented. Betanin and quinone, extracted from beets and Sencha, was preloaded on the sulfonated carbon nanosphere as the composite. While sulfonated carbon nanosphere were fabricated by hydrothermal synthesis of renewable biomaterial, followed by surface functionalization - sulfonation for increasing the loading capacity of nanoparticle. Nanostructured morphology and surface functional groups were examined and confirmed by SEM and IR spectroscopy.

Specific capacitance can be boosted up through optimizing the particle size, morphology and surface polarity of carbon substrate and the type of electrolyte. From the experimental result, it is believed that the nano-architecture, with active functional groups, of carbon nanosphere enables the efficient charge transport and electrode stability, allowing the composite with high capacitance (94–209 F g^{-1} at a current density ranging from 1 to 4 mA cm^{-2}), high capacitance retention of over 90% after over 20,000 cycles respectively, and over a wide range of temperature. Superior electrochemical performance of both betanin/sulfonated and quinone/sulfonated carbon supercapacitor can be attributed to the large accessible surface area of the porous structure, low interfacial resistance and its structural stability. It shows that they have relatively higher tolerant towards heat and extreme pH mediums. The green electrochemical capacitor exhibits a promising capacitive performance of 209 F g^{-1} with high capacitance retention of over 90%, opening up new possibilities for the production of environmental friendly, cost efficient and lightweight energy storage system using renewable biomass as the basic building materials without harming the environment.

【評語】200008

The objective of this project is to find an environmentally benign alternative for building various key components of supercapacitors structures. Two designs of betanin/sulfonated carbon supercapacitor and quinoru/sulfonated carbon supercapacitor were invented .The article is novel and show, high potential application in future.