Enhancement of CNT Supercapacitors by Electrophoretic Deposition and Air Oxidation of CNTs

王粘富、葉競榮

E-mail: 9707279@mail.dyu.edu.tw

ABSTRACT

There are several advantages of conventional capacitors, for example, refreshing and discharging quickly, high power density and long cycle life, etc., but they suffer from a low energy density. With a hope to overcome this shortcoming, the idea of supercapacitors was created, however, up to this time, it still has many problems to be solved, to name just a few, aging and modest energy density. In this research, these are two of the important topics we worked on. In the past, we grew up carbon nanotubes on graphite electrodes directly using nickel as catalyst, but their performance ages after some ten cycles. This research made use of electrophoresis deposition to deposit carbon nanotubes on graphite electrodes, then the carbon-nanotube-deposited graphite electrode was heated to over 500°C in air, in order to improve the aging problem and to increase the energy density . The purpose of this oxidation process was trying to change the structure of the deposited carbon nanotubes and to increase the roughness of their surfaces with a hope to increase the capacitance of the designed supercapacitors. We found ,at 600°C, the best results can be achieved. The electrochemical behavior of the designed supercapacitors was analyzed with a three-electrode cyclic voltammetry (CV) system. By the electrophoresis deposition, carbon nanotubes formed the interlacing maneuver of small hole structures. In addition to the higher surface area provided by carbon nanotubes themselves, these small holes can also let charged particles get in and thus increase the capacitances of the designed supercapacitors. The electrophoresis of carbon nanotubes was made possible by adding into the suspension as electrolyte for EPD. However, magnesium ion may cause the deposited carbon nanotubes to peel off from the graphite electrode in the sulfuric acid electrolyte. Hence after the electrophoresis, magnesium ions were removed chemically or by a second oxidation process. With all these efforts, the capacitance of the supercapacitors increased and the aging problem had been improved significantly.

Keywords : carbon nanotube ; supercapacitor ; aging ; electrophoretic deposition

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