Polyaniline coated aligned carbon nanotubes for electrochemical supercapacitors

Fedorovskaya E.O.*, Okotrub A.V., Bulusheva L.G.

Nikolaev Institute of Inorganic Chemistry, SB RAS, 630090, Novosibirsk, Russia
**e-mail: fedorovskaya-eo@yandex.ru*

Electrochemical capacitors, known as supercapacitors, have attracted great interest as promising energy storage devices due to their high power energy density and long cycle performance than conventional dielectric capacitors. Among various conducting polymer, polyaniline has emerged as the one of the most promising class of active materials for electrochemical capacitor, due to its high capacitive characteristics, easy processing and environmental friendliness. Carbon nanotubes commonly possess large specific surface area, remarkable chemical inertness and physical stability. Formation of three-dimensional conducting network from aligned nanotubes coated with a layer of polyaniline, involved in the Faraday processes, seems to be promising for obtaining of high-capacitance supercapacitors. Direct contact of carbon nanotubes with conductive substrate provides fast charge/discharge and high stability of capacitor. Arrays of vertically aligned carbon nanotubes have been grown on silicon substrates using an aerosol-assistant catalytic chemical vapour deposition (CCVD) method. The carbon nanotubes were synthesized from toluene. Ferrocene was used as a catalyst source and its concentration in a solution was equal to 2 wt.%. The substrate was gradually heated to 800°C in an argon flow and injection of the ferrocene–toluene solution was performed for 30 or 60 min. Deposition of polyaniline was carried out in two ways. The chemical polycondensation of aniline occurred under an influence of an oxidant in an acidic environment. In our experiments we used potassium dichromate. The electrochemical deposition of polyaniline was performed during the carbon nanotube electrode cycling in a solution of aniline in sulfuric acid in a three-electrode cell. Synthesis time was 500-4000 seconds, the potential range was [-300, 700] mV. A study of the electronic structure of the carbon nanotubes and composites was carried out by X-ray photoelectron spectroscopy and X-ray absorption spectroscopy (NEXAFS) near the K-edges of carbon and nitrogen. The length and defectness of CNTs were determined by Raman spectroscopy and scanning electron microscopy. The electrochemical measurements were carried out on a potentiostat Elins P-30S working in potentiodynamic mode. Electrochemical measurements showed that the capacity of carbon nanotube electrode increases with the polyaniline coating formation. Furthermore, specific capacity for the composites based on the aligned carbon nanotube arrays is higher than that for the composites from random nanotubes.

The work was financially supported by the Russian Foundation for Basis Research (grant No. 10-03-91163).