Single-walled carbon nanotubes: from synthesis to applications

Albert G. Nasibulin*

Skolkovo Institute of Science and Technology,
Nobel str. 3, Moscow, Russia 143026
and
Department of Applied Physics,
Aalto University School of Science, Espoo, Finland

The unique properties of single-walled carbon nanotube (SWNT) films, such as high porosity and specific surface area, low density, high ratio of optical transmittance to sheet resistance, high thermal conductivity and chemical sensitivity, and tunable metallic and semiconducting properties, open up avenues for a wide range of applications.

Direct integration of the CNTs produced by the aerosol methods into different applications, especially for high-performance flexible and stretchable electronics, is discussed. Produced SWCNT/polymer composite films have exhibited excellent optical and electrical properties as well as high mechanical flexibility. Wide variety of potential application of these networks has been already successfully demonstrated.

Transparent, stretchable and flexible energy storage devices have gathered great interest due to their suitability for display, sensor and photovoltaic applications. In this paper, we report the application of aerosol synthesized SWCNT thin films as electrodes for electrochemical double-layer capacitor (EDLC). SWCNT films exhibit extremely large specific capacitance (178 F g^{-1} or 552 μF cm^{-2}), high optical transparency (92%) and stability for 10000 charge/discharge cycles. A transparent and flexible EDLC prototype is constructed with a polyethylene casing and a gel electrolyte.

Stretchable all-solid supercapacitors based on aerosol synthesized single-walled carbon nanotubes (SWCNTs) have been also successfully fabricated and tested. High quality SWCNT films with excellent optoelectrical and mechanical properties were used as the current collectors and active electrodes of the stretchable supercapacitors. A transmittance up to 75% was achieved for the supercapacitors made from the assembly of two PDMS/SWCNT electrodes and a gel electrolyte in between. The transparent supercapacitor has a specific capacitance of 17.5 $F \cdot g^{-1}$ and can be stretched up to 120% elongation with practically no variation in the electrochemical performance during 1000 stretching cycles.

This research was supported by the Russian Science Foundation (project № 17-19-01787).

* E-mail: a.nasibulin@skoltech.ru