Nanostructured Carbon Shows Promise for Energy Storage in Supercapacitors

UT-B ID 200301297

Technology Summary

Researchers at ORNL have designed andsuccessfully developed a carbon nanomaterial with pore sizes ranging from the macropore to the mesopore, a promising material for the high energy storage demands of modern supercapacitors. Short power interruptions cost U.S. industry $80 billion annually in lost productivity. Waste energy from deceleration could be captured and stored in megapored nanostructured carbon, potentially lowering energy use by 30 percent.

In this device, the macropores in the carbon material have been designed at a size ranging from 0.05 microns to 100 microns, and the mesopores range from 18 angstroms to 50 nanometers. The electrical conductivity can be tuned by adjusting the size of the pores on the carbon surface. This range of pore sizes provides a highly adsorbent surface area, which results in greater levels of charge storage capabilities than are available in existing commercial carbon-based electrode materials. The monolithic structure also gives the device both high permeability and fast mass transfer kinetics.

The carbon columns are made of a hierarchically porous carbon that is first clad with a heat-shrinkable tube and then encapsulated in a metal or PEEK (polyetheretherketone) tube. The device is made in four steps: (1) preparation of the precursor rod, a dense packing of solid beads filled with a polymeric resin; (2) carbonization of the resin and removal of the solid beads; (3) graphitation of the porous carbon rod; and (4) encapsulation of the rod into a piece of tubing.

Current supercapacitor technologies cannot meet the growing demands for high power energy storage. Meeting this challenge requires the development of new electrode materials. This megapored nanostructured carbon is a promising material for supercapacitor electrodes with superior power and energy performance.

Advantages

This material has excellent electrical conductivity; corrosion resistance; high temperature, chemical, and mechanical stability; and a percolated pore structure. This highly adsorbent carbon has a larger active surface area that potentially can store more energy than can be stored in conventional carbon aerogel and activated carbon.

Potential Applications

This nanostructured carbon material is ideal for electrical energy storage in today's advanced supercapacitor devices. Its cost compares favorably with aerogel carbon.

Patent

Sheng Dai, Georges A. Guiochon, and Chengdu Liang, *Robust Carbon Monolith Having Hierarchical Porosity,* U.S. Patent 7, 449, 165, issued November 11, 2008.

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