news@nature.com
The best in science journalism

Published online: 13 August 2007; | doi:10.1038/news070813-3

Paper holds the power

Nanotubes plus paper make for flexible batteries.

Katharine Sanderson

Small, flexible wafer-thin batteries made out of paper are the latest product of carbon-nanotube research.

A paper battery can be bent, and springs back into shape.

Rensselaer/Victor Pushparaj

The device, made by Pulickel Ajayan and colleagues at Rensselaer Polytechnic University, Troy, New York, is made with cellulose — the stuff of ordinary paper — impregnated with carbon nanotubes, which act as electrodes in the battery.

It sounds simple, but proved tricky to do; cellulose is insoluble in almost all solvents, making it difficult to embed the nanotubes. But Ajayan used a kind of solvent known as an ionic liquid to dissolve the woody stuff, so that it could be impregnated with multiwalled carbon nanotubes.

After the cellulose/nanotube paper is made in this way, the ionic liquid can be completely removed, leaving a sheet of paper that can be cut to size, bent, rolled up or twisted, and which springs back into shape with ease. When the paper is layered with a thin layer of lithium metal, a battery is created.

As a bonus, if some of the ionic liquid is left behind it acts as a built-in electrolyte, turning a stack of such paper into a supercapacitor.

Compromise solution

Batteries and supercapacitors each have their advantages. Batteries can store more electricity. But they also require a chemical reaction to transfer electrons, whereas supercapacitors don't — they use electrostatic interactions instead, and so can charge and discharge very quickly.

Ajayan thinks that his paper could be the basis for a halfway house between the two, simply by leaving some ionic liquid in the paper. "There seems to be the possibility of an ideal compromise," he says. His paper can combine some of the storage capabilities of batteries and some of the power discharge characteristics of capacitors: "a device capable of storing useful quantities of electricity which can be discharged very quickly," he says.

Tests on the systems show that they work over a wide temperature range, and don't deform if they are frozen and then thawed out again. At room temperature the devices can provide 13 watt hours per kilogram — much less than typical nickel cadmium or lithium batteries on the market, but more than twice what a supercapacitor can produce. Ajayan predicts a commercial product within a few years.

Visit our newsblog to read and post comments about this story.

Top

References

1. Pushparaj, V. L. *et al*. *Proc. Nat. Acad. Sci. USA* **104**, 13574-13577 (2007).

Top