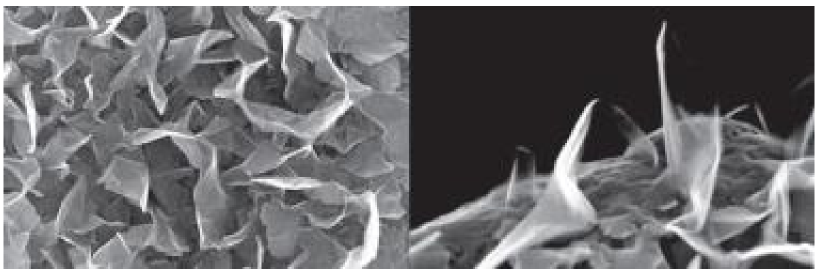
New ultracapacitor recharges in under a millisecond

September 24 2010, by Lin Edwards



(A) Plan SEM micrograph of coated Ni electrode. (B) SEM micrograph of a coated fiber, showing plan and shallow-angle views. Image credit: *Science*, DOI:10.1126/science.1194372

(PhysOrg.com) -- A new ultracapacitor or electric double-layer capacitor (DLC) design has been announced in the journal *Science* this week, and could pave the way for smaller and lighter portable electronics devices.

Ultracapacitors are capable of charging and discharging in only seconds and this gives them an advantage over batteries, which take much longer, and make them extremely useful in applications such as regenerative braking. However, for some applications even a few seconds is too long, and this is where a new nanoscale ultracapacitor comes in. Researchers in the US have built an ultracapacitor from nanometer-scale fins of graphene, and this design gives them a device that can charge/discharge in under 200 microseconds.

Ultracapacitors store charge in electric fields between conducting surfaces, so a larger surface area of conducting surfaces enables the device to hold more charge. A larger amount of stored charge enables ultracapacitors to work in devices needing more energy than ordinary capacitors can provide, and they can deliver the energy much faster than a battery.

A team of researchers led by John Miller, president of JME, an electrochemical capacitor company based in Shaker Heights, Ohio has been able to increase the speed of the ultracapacitor by redesigning the electrodes to give more surface area. The new electrode, developed by Ron Outlaw, a team member from the College of William and Mary, in Williamsburg, Virginia, consists of sheets of graphene sticking up vertically from a graphite base. The graphene sheets are made of carbon one atom thick, and grown by a plasma-assisted chemical vapor deposition process. The graphite base is 10 nanometers thick. Miller described the design as resembling "rows of 600-nanometer tall potato chips standing on edge."

The design allows for much faster charging and recharging than stacked graphene sheets used in earlier ultracapacitors or the pored surfaces of activated carbon ultracapacitors.

According to Miller's team, the new ultracapacitor could replace bulky capacitors in portable devices to free up more space while still smoothing out peaks and troughs in power supplies. It has been tested in a filtering circuit in an AC rectifier, a task at which other ultracapacitors fail. (AC rectifiers tend to leave a voltage ripple that the capacitor smooths out.) Other ultracapacitors fail because their porous electrodes make them act like resistors in filter circuits. The new ultracapacitor worked well in the test, which means they could replace the current capacitors, which are six times larger.

Ron Outlaw said work is continuing on increasing the capacitance and attempting to make the graphene sheets taller and more parallel with the aim of finding the perfect balance of maximum charge storage with minimum restriction of ion flow in the electrolyte. As size and weight of the ultracapacitors are reduced, they will find more applications in areas such as airlines, the military, and NASA.

More information: John R. Miller et al., Graphene Double-Layer Capacitor with ac Line-Filtering Performance, *Science* 24 September 2010: Vol. 329. no. 5999, pp. 1637 - 1639.
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