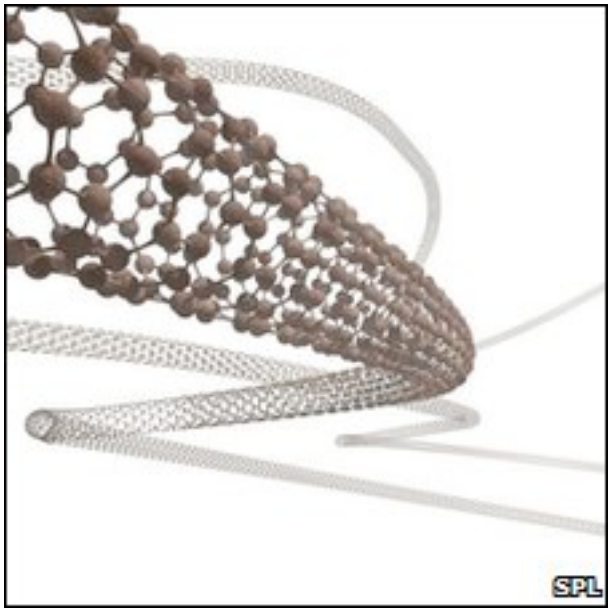
Nanometre 'fuses' for high-performance batteries



Nanotubes are wire-like molecules billionths of a metre across

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Minuscule tubes coated with a chemical fuel can act as a power source with 100 times more electrical power by weight than conventional batteries.

As these nano-scale "fuses" burn, they drive an electrical current along their length at staggering speeds.

The never-before-seen phenomenon could lead to a raft of energy applications.

Researchers reporting in Nature Materials say that unlike normal batteries, the nanotubes never lose their stored energy if left to sit.

The team, led by Michael Strano of the Massachusetts Institute of Technology, coated their nanotubes - cylinders just billionths of a metre across - with a chemical fuel known as cyclotrimethylene trinitramine.

"One property that nanotubes have is that they conduct heat very, very well along their length, up to a hundred times faster than in metals," Dr Strano told BBC News.

"We asked what would happen if you perform a chemical reaction near one of these, and the first thing we found is the nanotube will guide the reaction, accelerating it up to 10,000 times."
The team used a laser or an electric spark to set off the reaction in a bundle of coated carbon nanotubes, filming the results using a high-speed camera.

High-speed video of less than a tenth of a second of the reaction

But they also found that, through a mechanism that is still poorly understood, the process creates a useful voltage - a phenomenon they have dubbed "thermopower waves".
Their nanotube bundles carry, gram for gram, up to 100 times as much energy as a standard lithium-ion battery.
Since just a tiny amount of energy is needed to start the reaction before it becomes self-sustaining, Dr Strano says it could be initiated in a small device with the energy in the push of a finger.
And unlike standard batteries, the stored energy would not leak away over time, and requires none of the toxic, non-renewable metals in many batteries.
The current implementation is for a one-time use, but Dr Strano says he believes the approach could be adapted to a system in which the fuel is doused over the nanotubes after the initial fuel supply is burned and converted into electrical energy.
"I'm interested in the fuel cell concept," he said. "The conventional fuel cell has been around since the 1800s but corrosive fuels, catalytic deactivation and complexity have been a hurdle.
"From an engineering standpoint, thermopower waves could be a very simple alternative."
For the team, however, the first task is to understand just what is going on in the nanotubes, whose mechanical and electrical properties continue to surprise researchers in a number of fields.
"What we've discovered is more than just a replacement for batteries," Dr Strano said.
"To our knowledge, it's a new scientific area for research. There are many, many questions about these waves: what their limits are what the applications might be."