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Fuelling innovation

All about fuel cells, paper battery and Nobel prizes

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There have been approximately 100 incidents of overheating reported globally, states a communiqu, dated October 16, on www.wirelessandmobilenews.com. "No serious injuries or property damage have been reported. Over 46 million of the batteries were shipped."

At the time of writing, a search on Google News brings up the tale of a businessman and his family who are `lucky to be alive after receiving an electric shock from the man's cell-phone battery, which exploded while being charged,' as in Pietermaritzburg-datelined posting on www.news24.com. `Nokia battery explodes, flies across room, jumps into bed, burns two,' reads a headline on http://arstechnica.com, talking about the same incident.

Can there be a better way to power cellphones? The answer seems to be yes.

"One of the likely possibilities will be fuel cells," says T. Pradeep, Professor, Department of Chemistry and Sophisticated Analytical Instrument Facility, Indian Institute of Technology, Madras. "Miniaturised fuel cells are available and charging them with methanol is a tested option," he adds, during the course of an e-mail interaction with eWorld.

"The energy source can be ethanol as well. With improved storage materials, you may not be carrying liquids such as methanol but a solid or gel with the fuel trapped inside."

All high-energy materials have risks, Pradeep reminds. But, reassuringly, these risks are contained and only very small quantity of materials is used. "Let us not forget that we do use radioactive materials as medicines. They are not bombs."

The `battery' space saw a leap when Pulickel Ajayan and his team (including many Indians), in Rensselaer Polytechnic University, US, unveiled not long ago a small, flexible waferthin device, made with "cellulose - the stuff of ordinary paper - impregnated with carbon nanotubes, which act as electrodes in the battery," as www.nature.com reported.

The battery can be `rolled, twisted, folded, or cut into numerous shapes with no loss of integrity or efficiency, or stacked, like printer paper, to boost total output,' explains Wikipedia in a page on the invention.

"They can be made in a variety of sizes, from postage stamp to broadsheet. Their light weight and low cost make them attractive for portable electronics, aircraft, automobiles, and toys (such as model aircraft), while their ability to use electrolytes in blood make them potentially useful for medical devices such as pacemakers. In addition, they are biodegradable, a major drawback of chemical cells."

The nanotube battery is an excellent idea and it may be tested for applications such as what Rensselaer has come up with, opines Pradeep. "The device reported by Ajayan is both a battery and a supercapacitor. Right now the principal problem with such materials for large-scale applications such as mobile phones will be the cost of high quality nanotubes in quantities. Once this problem is solved, these devices are ready for the market." Interestingly, an October-8-dated story on http://inventorspot.com is about battery manufacturer Rocket of Korea advertising its `flexible and thin' product. "The battery is designed for frequent RFID users, those who make smart cards, and individuals working in the cosmetic and drug delivery system to help power up small items," describes Tamara Warta, in that article. "It can give juice to tiny, convenient electronics such as tooth whiteners, moisturisers, and microdermabrasions."

Nano was in the news, when "one of the first real applications of the promising field of nanotechnology" won the Physics Nobel this year. Albert Fert of France and Peter Gr□nberg of Germany shared the prize `for the discovery of Giant Magnetoresistance' or GMR. The Physics prize is an early recognition of the power of artificial nanostructures, explains Pradeep. "Although the prize was awarded to the effect of GMR, this works only when the materials prepared; `the magnetic multilayers' are nanometer thin. Thus the structures formed can be called as engineered nanostructures and the phenomenon is a result of the new capability to manipulate matter at the nanoscale." This discovery resulted in a new branch of science called spintronics, he adds. "This suggests that newer phenomena with nanoscale matter have the possibility to produce completely new technologies."

If you spin around the Net a query on the `spin' Pradeep talks about, you'd learn that while conventional electronic devices rely on the transport of electrical charge carriers - electrons - in a semiconductor such as silicon, the new science is about exploiting the `spin' of the electron rather than its charge, as www.nanotech-now.com educates. New generation `spintronic' devices are expected to be "smaller, more versatile and more robust than those currently making up silicon chips and circuit elements. The potential market is worth hundreds of billions of dollars a year."

This is how spintronic devices work: "(1) information is stored (written) into spins as a particular spin orientation (up or down); (2) the spins, being attached to mobile electrons, carry the information along a wire; and (3) the information is read at a terminal."

The site notes that the spin orientation of conduction electrons survives for a relatively long time (nanoseconds, compared to tens of femtoseconds during which electron momentum decays).

This makes spintronic devices "particularly attractive for memory storage and magnetic sensors applications, and, potentially for quantum computing where electron spin would represent a bit (called qubit) of information."

For starters, nanosecond is one billionth (or 10 to the power minus 9) of a second. And a femtosecond is "one billionth of one millionth of a second. For context, a femtosecond is to a second, what a second is to about 32 million years," says http://en.wikipedia. org.

Pradeep finds the unmistakable nano thread in the Chemistry Nobel too, this year, which recognised the pioneering contributions of Gerhard Ertl of Germany.

"Chemistry at the surfaces has been central to industrial revolution, modern agriculture, etc. Now it is being recognised also in the context of environmental protection, atmospheric processes and so on," he says.

"Chemistry discovered in the laboratory is fast becoming industrial products. This is happening in surface chemistry too. In fact this year's Nobel prizes in Chemistry and Physics are very much linked to applications around us." How so? The application of sophisticated tools is an absolute must to understand surfaces, although what happens in a real reactor may be far removed from the model chemistry happening in inside instruments, Pradeep elaborates.

With sophisticated tools, it is possible to see molecules in motion in real time and such investigations are becoming increasingly common these days. Ertl made pioneering contributions in this area.

"Surface processes were investigated with atomic detail in these studies and they set an example for later investigations. Obviously these studies, and chemistry as a whole, happen at the nano dimension. Catalysts, in detail, being nano, surface activation is nanochemistry in action." Ideas that should make eminent sense for those who are ready to scratch the surface.

Background

Pradeep did his B.Sc and MSc from Calicut University (Chemistry main 1980-85), and Ph.D. from Indian Institute of Science. He was Indo-US Science and Technology Fellow, Lawrence Berkeley Laboratory, University of California, Berkeley, and Post-doctoral Fellow, Purdue University, Indiana. Pradeep has been a Visiting Scientist and Professor in many institutions, including EPFL, Lausanne, Switzerland; University of Leiden, Netherlands; Pohang University of Science and Technology, South Korea; Institute of Chemistry, Academia Sinica, Taipei, Taiwan; and Purdue University, Indiana. His research interests are in molecular and nano materials, nano chemistry, spectroscopy, ion scattering, and instrumentation dmurali@thehindu.co.in.

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D.MURALI

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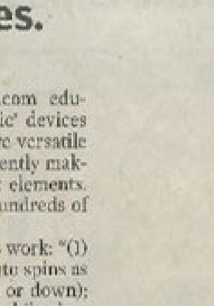

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