

POWER GENERATION IN NANOTUBES

Elementary, my dear

A simple bit of innovation could open up a multibillion-dollar market for Ajay Sood



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THE idea is so disarmingly simple that we can't help asking this question; why has nobody else thought of this before? All great discoveries seem simple in retrospect, but this one is simple in a new way. It can be taught to high school students, using the simplest of mathematics. The experiment can be performed with minimal equipment. And the discovery is extremely useful commercially too.

Ajay Sood, professor of physics at the Indian Institute of Science in Bangalore, and his student Shankar Ghosh blew a gas over a piece of wire and watched it generate electric current. Two years ago he had blown water over ultra-tiny wires — carbon nanotubes — and watched them generate a current too. Carbon nanotubes are bits of exotica for the layperson; you expect them to behave in ways that you had not known before. Some of the wires in the second experiment (apart from the nanotubes) were semiconductors, not too different from the ones inside your ubiquitous personal computer. They are the stuff of everyday life. You could build the device with a few thousand rupees.

Sood's first work on the phenome-

non was published in *Science*. We have known about carbon nanotubes for some time, but no one had thought that water flowing over them would generate a voltage and thus a current. The current was feeble. To generate electricity commercially we needed more powerful currents. Which was what Sood found the second time.

This time Sood passed pure compressed gases like oxygen or nitrogen over wires kept at an angle. The wires were nanotubes as well as semiconductors with some impurities, of the kind physicists called 'doped'. The wires again produced a current, but this time the effect was more powerful. If he doubled the speed of the gas flow, the strength of the current increased four times. Even gentle human breath produced a measurable effect. This phenomenon was more useful than the first. Sood published this work in the journal *Physical Review Letters* last week.

Why do the wires generate electricity? It is a combination of two laws, both known for close to two centuries. The first law is called Bernoulli's principle;

the pressure and temperature of a gas decreases with its speed. The second law is called the Seebeck Effect; a piece of wire with a temperature difference between its two ends will generate a current. In Sood's experiment, the wire's inclination increased the speed of the gas, exactly the way an aeroplane's wings do. This in turn produced a difference in temperature between the two ends of a wire. A voltage was generated and a current flowed. High school physics.

The Seebeck Effect was discovered in 1821. Bernoulli lived in the eighteenth century. So why did the 'Sood Effect' take so long to be discovered? "I do not know the answer," says Sood, "except to say that this is not something that can be discovered through serendipity."

High school physics meets nanotech: Ajay Sood (R) with student Shankar Ghosh passed gases over carbon nanotube wires to generate measurable electric current

Sood found only what he was looking for. He had worked for long on carbon nanotubes and could make guesses about their behaviour. Once he found that the nan-

otubes generated a voltage, he could extrapolate and try the experiment with gas and semiconductors. Without this prior knowledge, who would try to blow gas over a wire of semiconductor wire and see what happens? There are plenty of other ways to keep oneself busy.

Sood's discovery can be used to generate electricity. You could bundle several wires, and all of them would produce currents that can be added up and transmitted. Windmills generate power from winds, but Sood's technique needs no moving parts. You can put wires wherever there is a gas flow, and generate electricity. The current is proportional to the speed of the flowing gas, so the principle can be used to measure velocity directly. Velocity sensors form a multibillion dollar market. It is not out of place to mention that IISc has filed a patent application in the Patent Cooperation Treaty.

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