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Cold fusion rides again

Physicists scoff, but enthusiasts say they now have hard evidence that proves room temperature fusion is real. Bennett Daviss takes a closer look

FROM a distance, the plastic wafer Frank Gordon is proudly displaying looks like an ordinary microscope slide. Yet to Gordon it is hugely more significant than that. If he is to be believed, the pattern of pits embedded in this unassuming sliver of polymer provides confirmation for the idea that nuclear fusion reactions can be made to happen at room temperature, using simple lab equipment. It's a dramatic claim, because nuclear fusion promises virtually limitless energy.

Gordon's plastic wafer is the product of the latest in a long line of "cold fusion" experiments conducted at the US navy's Space and Naval Warfare Systems Center in San Diego, California. What makes this one stand out is that it has been published in the respected peer-reviewed journal *Naturwissenschaften*, which counts Albert Einstein, Werner Heisenberg and Konrad Lorenz among its eminent past authors (DOI: 10.1007/s00114-007-0221-7). Could it really be true that nuclear fusion can be coaxed into action at room temperature, using only simple lab equipment? Most nuclear physicists don't think so, and dismiss Gordon's pitted piece of plastic as nothing more than the result of a badly conceived experiment. So who is right?

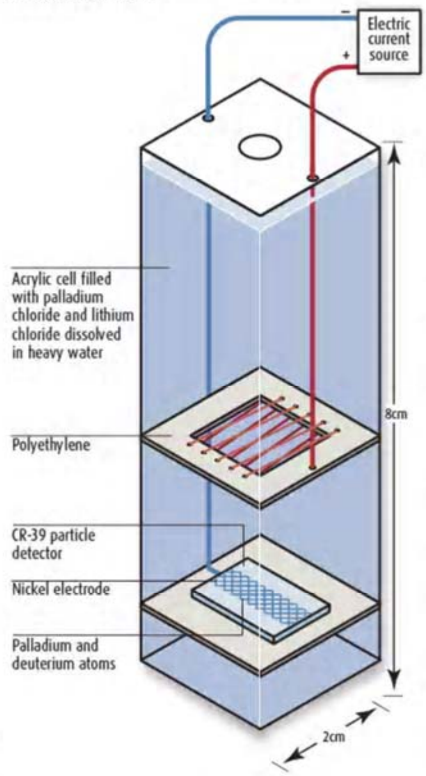
The notion that cold fusion might be possible burst onto the scene in March 1989. That's when chemists Martin Fleischmann and Stanley Pons, working at the University of Utah, announced that they had run a table-top electrolysis experiment in which a fusion reaction took place, producing more energy than it consumed. A world of endless, virtually free fuel seemed to be in the offing – but not for long. Fleischmann and Pons's results quickly proved elusive in other research labs. The hapless pair were laughed out of mainstream science, and most nuclear physicists since have refused to give the slightest credence to the idea.

Not everyone gave up on cold fusion, however. Electrochemists Pamela Mosier-Boss and Stanislaw Szpak at the San Diego centre's navigation and applied sciences department were intrigued. Fortunately, so was Gordon, their boss, who provided limited funding for experiments. Mosier-Boss and Szpak have now run hundreds of tests at weekends and during their spare moments, and have published more than a dozen papers in various peer-reviewed journals (*New Scientist*, 29 March 2003, p 36).

Typically, these table-top experiments have involved lowering an electrode made of the precious metal palladium into a solution of an inert salt dissolved in "heavy water" – in which a large proportion of the hydrogen atoms are of the element's heavy isotope deuterium. In deuterium, the atomic nucleus contains a neutron in addition to the usual single proton.

TEST-TUBE FUSION

The US navy's researchers pass an electric current through a solution containing palladium ions. As palladium builds up on the nickel substrate, deuterium atoms pack into the palladium's lattice structure and a mysterious reaction takes place. The pattern of pits left on a plastic particle detector suggests that nuclear reactions occur



Magnified view of the pits left behind in CR-39. Similar patterns are produced by alpha radiation from depleted uranium

When an electric current is passed through the solution, deuterium atoms start to pack into spaces in the palladium's lattice-like atomic framework. Eventually, after a period of days or weeks, there is approximately one deuterium atom for each palladium atom, at which point things start to happen.

Quite what happens or why isn't clear. Whatever it is appears to release more energy, as heat, than the experiment consumes. Proponents of cold fusion claim that the excess energy comes from a nuclear fusion reaction involving the deuterium nuclei.

To get a fusion reaction going normally requires temperatures of millions of degrees, to give the nuclei enough energy to overcome the repulsion between the positive charges of their protons. The result is that two deuterium nuclei combine to produce either tritium – an even heavier hydrogen isotope – plus a free proton, or an atom of helium-3 and a free neutron. Either way the reaction also liberates a large amount of energy.

There is, however, no consensus for how cold fusion might work, and with research groups struggling to reproduce each other's results, most physicists dismiss the few watts of extra energy that emerge from experiments like Mosier-Boss and Szpak's as some kind of aberration. So rather than just looking for extra energy, the pair have deployed a detector long used by nuclear scientists, in an attempt to come up with convincing evidence that nuclear events are taking place.

That's where Gordon's sliver of polymer comes in. It is made of CR-39, a clear polycarbonate plastic that is commonly used to make spectacle lenses and shatter-proof windows – and which can also record the passage of subatomic particles. The neutrons, protons and alpha particles that spew from genuine nuclear reactions shatter the bonds within the polymer's molecules to leave distinctive patterns of pits and tracks that can be seen under a microscope.

Plastic fantastic

The use of CR-39 as a detector goes back decades. In the cash-strapped Soviet Union, most physicists were unable to afford state-of-the-art nuclear instruments. Instead, they became expert at "reading" CR-39 detectors, identifying particles from the shape and depth of the tracks they left behind.

Cold-fusion researchers at the University of Illinois and the University of Minnesota have used CR-39 since the 1990s, laying the foundation for Mosier-Boss and Szpak's latest experiment. "You don't need complicated instrumentation," Gordon says. "It's an easy detection tool."

Spzak has also developed a technique called co-deposition that speeds up the process of packing deuterium atoms into a palladium lattice. Instead of using palladium for the negative electrode in his electrolysis experiment, he uses nickel or gold wire which is bathed in a solution of palladium chloride and lithium chloride dissolved in heavy water. When a current passes through the solution, equal amounts of deuterium and palladium are deposited onto the wire (see Diagram, above). Within seconds, the palladium is packed with deuterium atoms and the reaction – whatever it is – begins. ▶

A SHORT HISTORY OF COLD FUSION

1984	1989	1989	1989	1989-1992	1998	2002	2005	2007
Martin Fleischmann and Stanley Pons begin experiments with electrolytic cells	Fleischmann and Pons announce excess heat production that they say indicates cold fusion is taking place	Electrochemists Pamela Mosier-Boss and Stanislaw Szpak at US navy's Space and Naval Warfare Systems Center begin trials	Panel of scientists appointed by US Department of Energy dismisses cold fusion	Melvin Miles at Naval Air Warfare Center, China Lake, California, tries to replicate Fleischmann and Pons's work, with mixed results	Szpak and Mosier-Boss publish evidence for tritium production in cold fusion cells	US navy releases report on its evidence for cold fusion	Szpak and Mosier-Boss report presence of other elements as evidence of nuclear reactions	Szpak and Mosier-Boss publish evidence for particle tracks

Mosier-Boss and Szpak say their cells show telltale signs of nuclear reactions, including anomalous amounts of tritium and low-intensity X-rays, just minutes after co-deposition starts. They say the electrode can sometimes become a few degrees warmer than the surrounding solution.

In their latest experiment, Mosier-Boss and Spzak placed wafers of CR-39 against the electrode. When they examined them after running the experiment, they discovered that regions nearest the electrode were speckled with microscopic pits, while those further away were not. A control experiment without any palladium chloride in the solution produced only a few randomly scattered tracks that could be accounted for by background radiation. The researchers have also deliberately inflicted chemical damage on the CR-39: it "looks like fluffy, popcorn-shaped eruptions" on the plastic, Mosier-Boss says, not pits or holes. They are trying to identify which particles might have left the tracks.

Nuclear scientists associated with the project who are well versed in reading CR-39 detectors say the results appear convincing. The pits "exactly mimic typical nuclear tracks in their depth, size, distribution, shape and contrast", says Lawrence Forsley, a physicist who has worked in fusion research for 16 years and is president of JWK Technologies in Annandale, Virginia, one of the San Diego centre's research partners.

Gary Phillips, a nuclear physicist who has used CR-39 detectors for 20 years to capture nuclear signatures and also works for JMK Technologies, is no less enthusiastic. "I've never seen such a high density of tracks before," he says. "It would have to be from a very intense source – a nuclear source. You cannot get this from any kind of chemical reaction."

Many outsiders are less impressed. Some physicists who have seen the initial results of the CR-39 experiments say Mosier-Boss and Szpak must have set up their equipment incompetently, read their data incorrectly, or somehow allowed radioactive detritus to contaminate their cells. Others suggest that anomalous background radiation from an unknown source or even showers of cosmic rays are responsible.

Forsley insists that those objections don't hold water. If there was enough background radiation in the San Diego lab to pock CR-39 wafers with so many pits in such a short time, Mosier-Boss and Szpak "would be cooked", he says. He also points out that any contamination of the experiment or external sources of radiation ought to scatter tracks randomly across the detectors, not concentrate them near the cells' electrodes as their detectors show.

> "The pits mimic typical nuclear tracks in their depth, size, shape and contrast"

Objectors also point to the difficulty of reproducing these results. While Mosier-Boss and Szpak claim they can produce the reaction at will, other labs have struggled to reproduce consistent, if any, results using co-deposition. One researcher who has had some success is Winthrop Williams at the University of California, Berkeley, who has replicated the navy's experiment with CR-39. At a meeting of the American Physical Society in March he reported similar numbers of pits around the negative electrode. "It is encouraging," says Williams. "I have more work ahead of me to precisely understand and interpret what I am observing."

The lack of a consistent theory to explain how the claimed fusion reaction might occur is another stumbling block. The science writer and debunker Shawn Carlson, who in the past has done research in nuclear physics, listened to Gordon and Mosier-Boss make their case at the National Defense Industrial Association conference in Washington DC last year. He was not convinced. "A collection of disjoint anomalies is more consistent with bad experimental technique than a great discovery," he says. "It would take independent verification from a number of labs to swing the tide in favour of cold fusion."

The sceptics are not having it all their own way, though. Several respected scientists at universities in the US, Europe and Asia are attempting to replicate the US navy's lab experiments. David Nagel, a physicist and research professor at George Washington University in Washington DC who has followed the cold fusion saga since its inception, reports a growing willingness by the US Department of Energy to consider funding experiments to follow up these tantalising hints.

Nagel also detects a more receptive climate at US military research outfits like DARPA and the Office of Naval Research, where he served as administrator and still has close ties. It's not just global warming or the end of oil that's opening people's minds, he says. "It's the weight of the evidence," with new results encouraging physicists to reconsider the case that was so swiftly and firmly closed 18 years ago. "This could be the year when things change for cold fusion," he says. Then he pauses. "Or maybe next year." ●

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www.newscientisttech.com/channel/tech/nuclear