Japanese cold fusion scientist reports neutrons and 70% energy gain

by Laurence Hecht

Japanese nuclear physicist Dr. Akito Takahashi presented the results of his three-year-long cold fusion research effort to an audience of physicists and other specialists at the Massachusetts Institute of Technology on April 15. Since October 1991, Takahashi's cells, based on a modification of the original Martin Fleischmann-Stanley Pons design unveiled in March 1989, have been steadily producing 30-70 watts of excess power (an energy gain of 70%) and a detectable amount of neutrons in the energy range of 2.45 and 3-7 megavolts (MeV).

Speaking softly and confidently, the 52-year-old senior physicist, who heads the nuclear engineering department at Japan's Osaka University, described in precise detail each aspect of his apparatus and experimental protocol which it was possible to present in the 90 minutes allotted. At the end of his talk, Takahashi released 50 pages of view graphs containing the blueprints for his cell, graphs of his experimental runs including neutron and heat measurements, and an outline of his theoretical views.

Questions from the audience, which numbered over 100, ranged from enthusiastic to skeptical of the calorimetry. Professor Emeritus Louis Smullin of the MIT Electrical Engineering Department, who chaired the event, tried to give each questioner a fair hearing, and the skeptics were clearly in a minority. The "lion's den," which an article in that day's *Wall Street Journal* had forecast Takahashi would encounter upon entering MIT's "bastion of skeptics," was not roaring very loudly. The following day, coverage in the *Boston Globe*, on Monitor radio, and assorted outlets was reasonably objective.

The Osaka device

The Osaka table top-sized device is a cell for electrolysis of "heavy water" (D_2O)—that is, water in which the deuterium isotope of hydrogen is united with oxygen—using a palladium cathode and a platinum anode. By passing a small electric current through an electrolyte of D_2O and lithium deuteroxide (LiOD), the deuterium gas is separated from the oxygen, and coaxed to take up a place in the regular crystalline lattice of the palladium metal cathode (negative electrode).

Palladium is one of many metals that will absorb hydrogen or deuterium gas, under a variety of conditions studied over many years. However, Fleischmann and Pons were the first to seriously investigate the possibility that the deuterium ions absorbed into the metal lattice could be made to fuse, that is, to unite their nuclei into a heavier element, releasing the enormous energy usually associated with a hydrogen bomb or the production of heat on the Sun. In the case of cold fusion, the nuclear reaction is taking place at a small and controllable rate that might some day be suitable for heating water in a home, powering an electric car, or providing power in remote locations.

The Osaka cell design is remarkably simple. Apart from the measuring and recording devices, Takahashi's whole cell fits in a lucite box about 4½″×4¾″×2½″. In the cell are the palladium cathode, about 7-8 inches of platinum wire anode, a thermocouple to measure the temperature, and the cooling coil. Another tank about the same size is used as a ballast and heat exchanger to help maintain a constant temperature. Here, or in a separate tank, a sheet of platinum black catalyst is used to recombine the deuterium gas not absorbed into the cathode with atmospheric oxygen. In addition to that, a chiller and a good-quality power supply are almost the only components needed to make the experiment run. The measuring devices for careful calorimetry, and especially for neutron detection, are a bit more complex, and a great number of variables, some perhaps unknown, might affect success. But it seemed clear from Takahashi's description and his view graphs that experienced scientists, even in Third World countries, could attempt his experiment with the calorimetry, and some could attempt the neutron detection as well.

In fact, the essential design is so simple that Takahashi reported to me in private discussion that he had to think it through carefully when enthusiastic Japanese high school students, and some teachers as well, wrote him asking for advice in duplicating the experiment. His final decision was to advise them not to attempt to do so, because of the danger of a hydrogen explosion, or of a fire from an overheated cathode should the experiment succeed in producing excess heat. He himself encountered two potentially dangerous moments in his experimental program. One was a small hydrogen explosion which was easily contained under the hood of his well-equipped laboratory, but could prove dangerous to an inexperienced experimenter. The other was the moment when large amounts of excess heat began to be produced.

After first turning off the current, and finding the heat increasing, Takahashi evolved a protocol for controlling the cell to avoid runaway heat production.

Takahashi's design differs from that of Fleischmann and Pons primarily in the configuration of the electrode. Fleischmann and Pons typically work with a needle-thin palladium cathode, on the order of 1 millimeter in diameter and a few centimeters in length. Takahashi, in his latest series of experiments, is using a thin, square-shaped plate of palladium 25 millimeters on a side, and 1 millimeter thick.

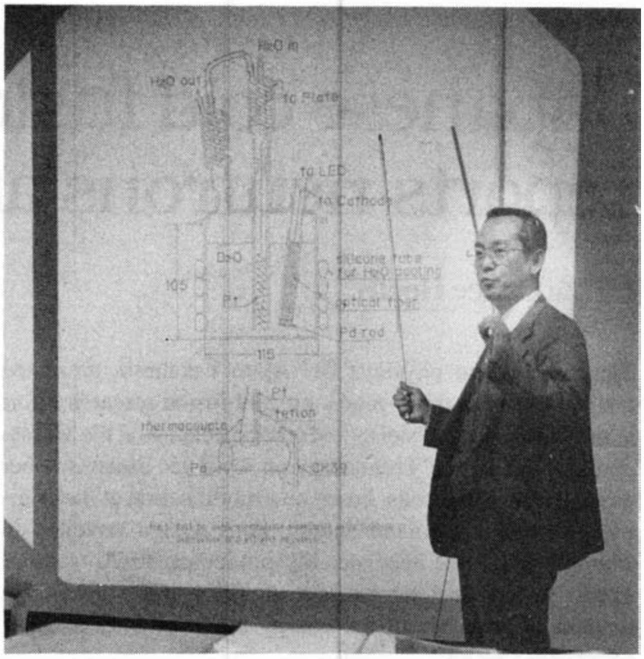
Takahashi's method of "loading" (driving the deuterium into the palladium lattice) is also different. While loading, he attempts to maintain the electrolyte at a constant temperature of 20° Celsius (about room temperature). He also varies the voltage and current in what he calls a "sawtooth" pattern, starting at about 0.25 amps and low voltage, and ramping up to about 5 amps and 25 volts maximum over the course of a 20-minute cycle, after which he drops abruptly to the starting level and repeats the cycle.

The theoretical challenge

Like most scientists who have taken the phenomenon of cold fusion seriously, Takahashi has attempted to come up with a theoretical explanation for it. Although he detects a certain number of neutrons at an energy level corresponding to that seen in ordinary hot fusion, there are two big anomalies in his experiment. First, the relatively large amount of excess heat and small amount of neutrons he has measured does not correspond to any of the presently known reactions for deuterium fusion. Second, he is finding neutrons with energy levels that do not correspond to any of the known paths for fusion. Yet his calculations show that his device generates 1,000 times more heat than any type of chemical reaction could account for. Takahashi thus describes the process as some form of "unknown nuclear fusion."

In all forms of fusion, the theoretical problem is to describe how two positively charged nuclei, which normally repel each other, are able to overcome the repulsion known as the "Coulomb barrier" (after the 18th-century French scientist who first measured the force acting between static electric charges), and unite to form a single, heavier nucleus. In the case of "hot" fusion, it is thought that the high temperature produces very large collisional energies, which allow a certain proportion of randomly colliding nuclei to crash together hard enough to fuse. Some hot fusion researchers have always questioned the randomness of the process, but the need for very high heat was never at issue.

Takahashi believes that the geometry of the palladium lattice guides the deuterons (deuterium nuclei) so that they come together, not as random pairs, but in larger groups of three, four, or more. Some call this "multi-body fusion." Through a combination of extrapolation from existing knowledge of the nuclear interaction, empirical data, and new theory, Takahashi has calculated that three deuterons can come together into an excited intermediate phase (a compound nucleus) as lithium-6, and then relax into a more stable form as helium-4 and a deuteron; or by a second, less probable branch, they may go to helium-3 plus tritium. The energy of the particles in the more probable branch (23.8 MeV per three-body fusion reaction) comes off as heat, which is what he believes is warming the water in his cell. In addition, some of the excited deuterons and tritons (tritium nuclei) produced in the less probable branch may interact with each other to produce the more conventional deuterium and tritium reactions and explain the small amounts of neutrons and tritium observed.



Akito Takahashi speaking at MIT on April 15 about his cold fusion experiment.

Though quite adept at nuclear physics, Takahashi is modest about his theory, and does not claim he has spoken the last word on the subject. He came to cold fusion by an unusual historical accident. In 1989, he was participating in a three-way joint effort between the U.S.A., China, and Japan respecting hot fusion. He was using his expertise in neutron detection to carry out exacting measurements of the neutron absorption capabilities ("capture cross-sections") of most of the elements in the periodic table. The events of April to June 1989 in China led to the recall of the team of Chinese scientists with whom he was working at Osaka. Finding himself with a reduced program just as the news of Fleischmann and Pons's experiment was reverberating around the world, Takahashi turned some of his efforts to this new field.

Following his April 15 appearance at MIT, Dr. Takahashi also presented his results to a seminar at the University of Texas, before returning to Japan. For more details on his theoretical views see *EIR*, March 20, p. 26.