

Nanometal Catalysis vs. Nuclear Bang

The discovery that nanometal deuterides can support cold fusion reactions occurred in 1992 with the first test of the A-Z DS-cathode concept. The first excess heat publication was their 1994 paper published in the *Proceedings of the Japan Academy* with title and abstract as follows:

"A New Energy caused by 'Spillover-Deuterium'"

Abstract: It was verified that a new kind of energy is caused by "Spillover-Deuterium" generated in a double structure (DS)-cathode with "Pd-black". Using this cathode, the authors confirmed the sustained production of a significantly abnormal amount of energy over a period of several months that could not be ascribed to chemical reaction energy. The chemical reaction energy of 0.1 [mol] Pd-black used is only 4 [kJ], but more than 200 [MJ] of excess heat was continuously produced for over 3000 [hr] at an average rate of 50-100 [kJ/hr] using a DS cathode with the same quantity of Pd-black. Intermittent operation over a period of two years using this structure proved the complete reproducibility of these results."

Spillover hydrogen is a name used in catalyst literature to describe a catalyst like Pd-black, for which the apparent area of the chemical-reaction catalyst is larger than a measured gas-adsorption catalyst area. A non-reactive gas like N₂ is used in the measurement of gas-adsorption area. The A-Z power rate 50-100 kJ/hr is the same as 14-28 Watts. The quantity 0.1-mol of Pd-black has a mass of 10.7 grams, which is somewhat more than the mass of Pd-black used in later experiments. The larger powder mass suggests that the first DS-cathodes may have had more inside volume and thinner walls than later versions.

There have been at least 13 A-Z heat-producing DS-cathode runs. The most important are the 1994 run shown in Supplement 1 page A1,4, the 1996 run discussed in Chapters 2.1-2.3, and the 2002 run on Supplement page A1,14. (Dates are publication dates) The main run plot for the 1994 paper shows the full run history, including an incubation period before cold fusion heat started. For the next roughly 8 runs A-Z did not plot the data accumulated during the incubation periods, where output heat equals input heat. For most readers, showing the data recorded during the incubation period would have had value, since a matching of measured total outflow heat power to input electrical power shows that the measurement of heat (calorimetry) has been properly carried out.

A more recent second goal of the A-Z program has been identification of nuclear fusion products, assumed to be mainly ⁴He, but maybe sometimes containing minute amounts of ³H and ³He.

These measurements were carried out using the quadrupole mass spectrometers described in the preceding Chapter. Their first observation of ^4He , and their later first observation of ^3He were exciting moments. The data proved to A-Z's satisfaction that the observed excess heat was due to D + D fusion. A second part of Supplement 1 (See footnote p. 17) includes mass spectrometer observations which document the presence of the two helium gases following desorption from post-run palladium black or its ZrO_2 + nanoPd equivalent. No ^4He was ever seen in the desorption gases from materials that had not yet been processed inside a DS-cathode. A ^3He peak was seen in the one case mentioned. It is much more difficult to see the ^3He peak in the presence of DH molecules than to see the ^4He peak in the presence of D_2 , because of the relatively small mass difference between ^3He and DH, as compared to the mass difference between ^4He and D_2 . The A-Z papers are a story of the author's growing understanding, rather than a big attempt to convince readers that cold fusion is real. Dr. Arata tries to explain the thinking that has guided his research. Independent of such thinking he assumes that the data speak for themselves.

In 2004 the US Department of Energy (DOE), in response to a request by some Low Energy Nuclear Reaction (LENR) scientists, asked the requesting scientists to prepare a Summary Document which would be examined by a DOE Review Panel made up of non-cold fusion scientists. This summary was published in *Proc. ICCF11* as Hagelstein *et al.* "New Physical Effects in Metal Deuterides". To help prepare the Summary Document your author was requested to provide information about the A-Z program. He examined the papers in his files and made copies of the published A-Z excess heat runs. These run plots are made available in Supplement 1, together with some of A-Z's mass spectra of desorbed gases. There were restrictions on the length of the Summary Document. The run plots were not included in the Summary Document. Only a small part of the discussion on A-Z's nano-Pd research could be included.

The Summary Document delivered to DOE was distributed to the members of the DOE review panel. Roughly a month later members of the DOE Review Panel assembled in Washington to hear a presentation by a few of the proponent authors of the Summary Document. McKubre was the main presenter-author of the experimental evidence for cold fusion. Later, in December 2004 DOE published "Report of the Review of Low Energy Nuclear Reactions", which is DOE's evaluation of the Review Panel's opinions. The key question examined was the validity of the observations of excess heat. The DOE evaluation states,

"The excess power observed in some experiments is reported to be beyond that attributable to ordinary chemical or solid state sources; this excess

power is attributed by proponents to nuclear fusion reactions. Evaluations by the reviewers ranged from : 1) evidence for excess power is compelling, to 2) there is no convincing evidence that excess power is produced when integrated over the life of an experiment. The reviewers were split approximately evenly on this topic."

"The hypothesis that excess energy production in electrolysis cells is due to low energy nuclear reactions was tested in some experiments by looking for D + D fusion reaction products, in particular ^4He , normally produced in about 1 in 10^7 in hot D + D fusion reactions. Results reported in the review document purported to show that ^4He was detected in five out of sixteen cases where electrolytic cells were reported to be producing heat. The detected ^4He was typically very close to, but reportedly above background levels. This evidence was taken as convincing or somewhat convincing by some reviewers; for others the lack of consistency was an indication that the overall hypothesis was not justified."

The Summary Document delivered to DOE can be downloaded by doing a Google Search for "New Physical Effects in Metal Deuterides", or by downloading www.LENR-CANR.org/acrobat, and then selecting [hagelsteinnewphysica.pdf](#) from a list of downloadable files. The Review Panel's evaluations can be downloaded by doing a Google Search for "Report of the Review of Low Energy Nuclear Reactions", or by downloading www.science.doe.gov/Sub/Newsroom/News_Releases/DOE-SC/2004/low_energy/CF_Final_120104.pdf .

Although DOE sought a review of cold fusion by peers, this goal was not accomplished, because of reasons described in the THEORY Section. Cold fusion is part of the quantum world, and more particularly, of the many-body quantum world of metals and semiconductors. Nuclear physics and nuclear engineering are not part of the quantum world of metals and semiconductors. Nuclear physics is mostly part of the impact collision world of scattering studies and plasma fusion. Nuclear physicists have been unable to accept that the many-body quantum world can create conditions for nuclear reaction. They have been unable to accept that it can prevent emission of energetic particles and gamma rays, while providing a coupling between nucleus and lattice that dissipates nuclear reaction energy so as to heat the lattice.

It is asking too much of the nuclear community, including the panel members, to pass judgment on experiments that violate their core beliefs (knowledge). They belong to the wrong discipline, and cannot be considered peers. Chemists are more accepting. They live in the quantum world of chemical orbitals, and encounter metal and semiconductor quantum mechanics in their materials science. Mostly they defer to the nuclear community when it comes to nuclear

reactions. There are chemists who are experts on the physical changes that are created by catalysis. Their field of interest can be considered part of the quantum physics of orbitals. However, most would consider the geometric changes required to enable hydrogen ions to behave like metal electrons to be outside their specialty. Cold fusion is made possible by geometric changes of embedded D-ions. Change from near-point geometry to 2-dimensional periodic symmetry can be catalyzed by nanometals in interface contact with ionic crystals. Change for near-point geometry to 3-dimensional periodic symmetry can be catalyzed by nanometals loaded beyond stoichiometric lattice symmetry. These catalyzed changes, and maybe others, cause embedded deuterons to change into a quasiparticle geometry which enables cold fusion. This intellectual mismatch between the nuclear physics discipline and the many-body physics discipline is what has led to this chapter being called "Nanometal Catalysis vs. Nuclear Bang".