FUSION facts

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ASME HOSTS SPECIAL COLD FUSION UPDATE SESSION PRESENTATIONS FROM ORNL, BUSH, AND HAGELSTEIN

CONTENTS DECEMBER ISSUE

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A. ASME COLD FUSION UPDATE

The American Society of Mechanical Engineers is to be congratulated for hosting COLD FUSION - A STATUS REPORT session in conjunction with the ASME Winter Annual Meeting held in San Francisco, CA December 12, 1989. This session on cold fusion is probably the most important public presentation of papers that has been given. The session was organized and chaired by two scientists from Oak Ridge National Laboratories, A. R. Sadlowe and Gordon E. Michaels.

"Evaluation and Verification of Cold Fusion", by Gary M. Sandquist (U of Utah) and Vern C. Rogers (Rogers and Assoc. Engr'g Corp. SLC, Utah).

Vern Rogers set the stage for the session by reviewing the experimental work that has been reported in replicating the F-P Effect. Extensive lists were presented of those laboratories that have successfully replicated one or more of the results of the Fleischmann-Pons cold-fusion experiment. More laboratories are being added to the success list every week from many parts of the world. The article lists 18 laboratories that measured excess heat; 14 laboratories that found neutrons above background; and 11 laboratories that measured tritium.

"A Preliminary Investigation of Cold Fusion by Electrolysis of Heavy Water. by C.D. Scott, J.E. Mrochek, E. Newman, T.C. Scott, G.E. Michaels, and M. Petek (Oak Ridge National Laboratory Publication ORNL/TM-11322 available from NTIS, Dept of Commerce, 5285 Port Royal Rd., Springfield, VA. 22161.)

The importance of this paper, presented by Dr. Gordon E. Michaels, is that it is the first publicly released information from a DOE-funded national laboratory.

Dr. Michaels reported the experimental efforts found using both open- and closed-system electrolysis using palladium rods about 0.55 cm in diameter by 8 cm long. Due to the size of the rods, excess heat was not recorded until after several hundred hours of operation. One of the charts shows the excess heat during the last 500 hours of experiment CF-3.

Figure 14 of the paper shows the electrolyte tritium content during the first 40 days (text and chart labeled "d", Title labeled "h") of Test CF-3. Tritium levels rose dramatically for the first measurement (day 2) and drops from this 25 times background level over the next 20 days. (Bockris of Texas A&M has reported a similar phenomena. Tritium apparently being consumed in other nuclear reactions? Ed.)

Neutrons were measured at somewhat above the background rate. At one point the neutron count was 3 1/2 standard deviations above background. On two other occasions, the neutron count rate exceeded the average values by three standard deviations.
The excess heat measured was usually in the range of 5% to 15%; however, during one 12-hour period excess heat up to 50% was measured. During this time the experimental uncertainty was calculated to be 3% to 5%.

The conclusions of the paper state: "Preliminary tests of the electrolysis of D_2O utilizing LiOD electrolytes and palladium electrodes have not confirmed the "cold fusion" phenomena. However, there have been several apparently anomalous neutron count rates, one unexplained 25-fold increase in tritium, and periods of many hours of apparent excess energy. None of these results has been precisely reproduced, nor can they be explained by conventional nuclear or chemical theory.

"Recent Stanford Work on Excess Heat Generation During Electrochemical Insertion of Deuterium into Palladium." by Dr. Robert A. Huggins (Stanford University).

Dr. Huggins reported on his continuing experimental efforts (interrupted briefly by an earthquake) in which he uses specially prepared coin-shaped palladium metal. Huggins stated that over 40 MJoules of heat per mole of Palladium had been measured in one cell and the test was still running. This amount of heat computes to about 8.5 watts per cubic cm of metal. Compare this figure to 50 watts per cubic cm of core in a large nuclear power plant.
Dr. Huggins has an excellent presentation on closed fusion cell calorimetry. We will try to get an abbreviated article from him on this subject for our readers.
With the careful preparation of the palladium, Dr. Huggins appears to obtain consistent results with no large bursts of energy but with identifiable "micro bursts". No neutrons appear to be produced by his experimental procedures, therefore, they no longer monitor for neutrons. Future work will emphasis going to higher temperatures.

"A Transmission Resonance Model for Cold Fusion", by Dr. R. T. Bush, California State Polytechnic University, Pomona, CA.

Dr. Bush bases his "scenario" or theory on a suggestion by Leaf Turner (1989, Letter to Editor, Physics Today, pp 140-141). Turner suggested that cold fusion may involve transmission resonances for deuterons diffusing through a periodic array of

wells formed by an array of deuteron-occupied wells. Bush's paper discusses in detail the conditions under which wave-like deuterons can achieve the transmission resonance. At resonance the probability of fusion is greatly increased.

The conditions for resonance are shown to be temperature sensitive. One test for the theory is the explanation of neutrons being emitted by deuterated titanium at -30 deg. C. It is of considerable interest that the calculations from the theory predict this observed phenomenon.

Calculations for other temperatures (of the metal lattice) are given for both titanium and palladium. Experimenters should be able to use this theory and the calculations in fusion cell experiments. It is expected that the theory will quickly be validated or modified with new data.

A postscript to the paper shows how the theory explains the importance of lithium in the fusion cell. It is shown, by the theory, that at temperatures near 20 and 103 deg C for lithium 6 and temperatures near 20 and 98 deg C for lithium 7 that the following nuclear reaction may be important:

Li + d --> 2 ^{4}He + energy.

The energy would be about 22.4 MeV for lithium 6. The author notes that failing to find ^{4}He should not be taken as critical to the experiment. Others have suggested that ^{4}He would be depleted by other nuclear processes.

"Coherent Fusion Theory." by Dr. Peter L. Hagelstein, M.I.T.

Although this paper searches for a "new mechanism", the theory presented is based on basic and known principles of physics. Dr. Hagelstein states "The basic premise of the theory is that off-resonant coupling between two fusing nucleons and a macroscopic system can occur through the electromagnetic interaction. An example of such a virtual fusion reaction is ^{a}He + ^{b}He ---> $^{a+b}$He For example, a proton and a deuteron can fuse conventionally to ^{3}He following the emission of a 5.5 MeV gamma. If instead a low energy photon is exchanged, ^{3}He is still created, but only in a virtual sense. ... exothermic incoherent reaction pathways exist for most of the virtual fusion products."

Hagelstein goes on to develop a model in which the reaction dynamics of a class of fusion reactions can be analyzed. The model is developed by the use of semiclassical field model expressed in Hamiltonian equations. Each step of the model is rigorously developed. The mathematical steps proceed to a semiclassical Hamiltonian diagonalization in Part III.

Part IV considers the Lattice Dynamics of the model and considers the mathematical terms of the criterion that must be met for exothermic virtual fusion reactions to occur. Hagelstein states "This constraint appears to be quite severe, and it is not obvious that it can be met without substantial enhancements in tunneling. (Perhaps the Bush approach can provide an explanation of conditions in which tunneling is enhanced).

Part V considers the mathematics for the combined nuclear and lattice system. This presentation is followed in Part VI by the mathematics for a "Driven Coupled Nuclear-Lattice System". An examination of the terms in the resulting equations leads to the following statement "... it appears difficult to produce substantial observable effects without enhancements of the tunneling probability."

In Part VI Hagelstein discusses Nonlinearities and Strong Driving Terms. In this effort, the author states that this discussion must be viewed as the beginning of a larger and possibly involved effort. The reader must appreciate the rigor with which Hagelstein is developing his model. With a few cycles between experimental data and model corrections, it is expected that this model will

contribute substantially to the development of cold fusion and a better understanding of the complex reactions that are being reported.

In the Summary and Conclusions in Part VIII of the paper, the author provides us with a discussion of the needs to be met and/or the outcomes of the model including the following:

1. The need for enhancement of tunneling may be overcome by a two-step beta/fusion reaction involving an intermediate neutron.

2. A connection is made between laser physics and the fusion problem.

3. Electromagnetic interaction may promote fusion events.

To those readers who can manipulate Hamiltonian equations, we highly recommend this work. We also recommend that you study this paper and share your ideas with the author.
NOTE: The above papers can be obtained from ASME, 345 E. 47 Street, New York, N.Y. 10017. The codes are Bush -- 89-WA/TS-3; Sandquist & Rogers -- 89-WS/TS-2; and Hagelstein -- 89-WA.TS-4. Copies are available for 15 months after the date of the meeting (12/12/89).

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B. MORE NEWS FROM U.S.

FORTHCOMING TECHNICAL PAPERS.

K.B. Whaley (U. of Cal. Berkeley), "Boson Dynamics of Deuterium in Metals.", Proceedings of the NSF-EPRI Workshop on Anomalous Effects in Deuterated Materials, Washington D.C., October 1989 (in press).

K.B. Whaley (U. of Cal. Berkeley), "Boson Enhancement of Finite Temperature Coherent Dynamics for Deuterium in Metals.", Physical Review B, to appear February 1990.

Drs. Scott and Talcot Chubb, Naval Research Laboratory, will be forwarding copies of their presentation given at the NSF-EPRI Workshop as soon as the current publication review is completed.

"Report of the Cold Fusion Panel.", A Report of the Energy Research Advisory Board to the Department of Energy, November 1989. In printing. [The letter by John W. Landis, Chairman of the Energy Research Advisory Board to the Secretary of Energy, James D. Watkins contains the following: "On November 8, the full Board reviewed the conclusions and recommendations drafted by the Panel and, after making only minor revisions, approved the report unanimously." The report contains the following Summary of Tritium Results: "Some experiments have reported the production of tritium with electrolytic cells. The experiments in which excess tritium is reported have not been reproducible by other groups. These measurements are also inconsistent with the measured neutrons on the same sample. Most of the experiments to date report no production of excess tritium. Additional investigations are desirable to clarify the origin of the excess tritium that is occasionally observed."]

Editor's Note: We have been assured that both the Cold Fusion Panel and the Energy Research Advisory Board had full access to the Oak Ridge reports and to the reports on tritium by scientists at Texas A&M. Members of both groups are still struggling with plasma physics and are apparently unaware that nuclear reactions in metal lattices do not follow plasma physics.

PUBLISHED TECHNICAL PAPERS - ARTICLES

Harry DeBell, (Aurora, CO), "Cold Fusion, Emerging Technology.", TESLA 89, The International Tesla Society's Journal of Power and Resonance, Vol. 5, No. 3, Jul/Aug/Sept 1989, pages 5-7. [DeBell cites physicist Ed Cecil (Colorado School of Mines as saying, "They have been telling us that you have to run the