FUSION facts

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A. FIRST ANNUAL FUSION CONFERENCE

History will record that most of the great pioneers of cold fusion met at the University of Utah Research Park on March 28-31, 1990 to report the progress made in cold fusion research. March 23, 1989, the date of the first announcement of the discovery of cold fusion for the production of excess energy, began a few weeks of international euphoria mixed with doubt and questions. One year later, the pioneers of cold fusion are gathering to report their results.

In spite of the difficulty in replicating the Fleischmann-Pons Effect, the continually growing number of successes and the intelligent melding of experimental observations with theory has produced the following facts:

1. Cold fusion is a reality. Careful experiments have demonstrated many times the production of tritium that can only be produced by nuclear reactions.

2. Excess heat is a reality. Regardless of the small amount of excess heat produced -- from 4% to 40% -- the production of excess heat over long periods of time is added evidence for cold fusion nuclear reactions.

3. Classical high-energy physics does not explain the observed experimental facts. Specifically, the equal branching of neutron production and tritium production is not found in cold fusion experiments. Tritium production far exceeds neutron production. In the cases where excess heat is measured, the sum of the tritium and neutron production fails to account for the excess heat.

The papers to be presented at the forthcoming conference will present added evidence in the pursuit of the above observations. This conference is expected to relate the important findings of the first year of world-wide research and to lay the groundwork for greater progress.

MAKE YOUR RESERVATIONS NOW

As we went to press, the conference was about 75% sold out. If you don't want to miss an historic conference get your reservation made immediately. We hope to see you there. For details about conference reservation see page 17.

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B. THE NO-NEUTRON DEUTERON

By Dr. H. Aspden, Dept. of Electrical Engineering
The University, Southampton, England

ARE THERE REALLY NEUTRONS IN AN ATOMIC NUCLEUS?

Although the discovery of solid-state or 'cold' fusion by Fleischmann and Pons [1] has tremendous implications for energy technology, it brings with it a physics lesson revealing to us that we may have been too quick to accept the neutron-proton structure of atomic nuclei.

The fact that deuterons can engage in nuclear fusion without a significant neutron signature should tell us something new about nuclear physics rather than cast suspicion on the claims of Fleischmann and Pons. The message is not, as many want to believe, that the claimed fusion is a myth based on a misinterpretation of some unknown energy process. Rather, the message is that we have been wrong all along in even thinking that what we know as a neutron has to exist within a deuteron.

The truth is that we only see neutrons in their free state. Neutrons have three measurable properties, apart from that of lacking a net electric charge. These properties are a mass, a finite lifetime, and a magnetic moment. Not one of these three properties can be measured for a neutron deemed to be a part of an atomic nucleus. Invariably, it is necessary to rely on the high energy scenario which supposedly blasts a neutron from its bound association in an atomic nucleus. Then the neutron measurements are made on those isolated neutral particles that form part of a thermal neutron beam or, if a high flux reactor is available, an intense enough 'cold' neutron beam. The magnetic resonance measurement is made by comparison with protons in a stream of water caused to flow through the same test channel.

Indeed, though we live with high energy physics that tells us that unstable particle forms are actually created in particle transformations provided we fire enough power into the target area, we seem not to realize that what we 'know for sure' is a neutron is only a product of high energy or hot reactions. In other words the neutron is created from not removed from the atomic nucleus.

It is manifestly obvious, therefore, that evidence of deuteron fusion at water temperatures and the lack of production of neutrons is a verification of the obvious, namely that there are no neutrons in deuterons.

A nuclear physicist who has studied fusion reactions triggered at energies high enough to create neutrons cannot imagine fusion without neutrons; neutrons are an inescapable consequence, the very sign that fusion has occurred. The reasoning is twofold: One is the vast amount of practical experience stemming from a half a century of intense nuclear research. These results are not something that can easily be set aside. The second is the belief that if an atomic nucleus has a charge equal to that of Z protons and a mass nearly equal to that of A protons then it must contain A-Z neutrons. This belief is maintained notwithstanding the fact that the neutron is appreciably more massive than the proton. This belief is mere hypothesis and manifestly illogical when one really questions why we have come to accept it.

Surprisingly the belief has survived the era of quark theory. The proton and the neutron are each supposed to comprise three quarks. The deuteron, however, is supposed to comprise a neutron and a proton. **Why cannot the deuteron comprise six quarks, so that when it fuses with another deuteron the twelve quarks can contrive to regroup without producing a neutron at all.**

Obviously, the discovery by Fleischmann and Pons has revealed something not contemplated by those who specialize in quarks, but, one must ask, could nuclear physicists really have embraced a theory which did away with neutrons as true denizens of the world of atomic nuclei?

NUCLEI AND POSITIVE HOLES

Dirac once impressed us by suggesting that a neutral vacuum could contain electrons which sit in positive holes in some kind of hidden world. In effect the vacuum is populated by vacancies filled by tenured charges awaiting the stimulation of sabbatical leave and a period of freedom in a larger world in which their presence can be widely recognized. Is it madness then to suggest that some of those nucleons we see in the atomic nucleus are in fact antiprotons which have asserted their more massive body action to fill one of those vacancies by pushing out an electron? Why should we not then picture the atomic nucleus as comprising Z protons in the presence of A-Z antiprotons which occupy and neutralize those positive holes or sites in that Dirac-style continuum. This view means that A-Z displaced electrons have been relegated to other duties, Z to act as boundary guards, the atomic electrons screening the nucleus from intrusion, and A-2Z electrons driven off to be absorbed by some other form of matter? The basic absorber could be A-2Z hydrogen atoms, bearing in mind that the proton-antiproton balance requires a surplus of A-2Z protons.

Now, the author is not advocating this specific nuclear hypothesis. It may be valid, but it is presented here merely to illustrate the fact that there are alternative viewpoints and to suggest that we may have been too short-sighted in our vision concerning nuclear structure. The main point made is that neutrons, as such, are not needed to form a picture of the normal atomic nucleus. The nucleus can comprise antiprotons as well as protons and, since both electrons and positrons are emitted from unstable atomic nuclei, it can even comprise these as well.

Nuclear physicists might then decry the idea that protons and antiprotons can sit side-by-side in an atomic nucleus. Surely they would mutually annihilate! However, again physicists are guided by their experience of life in a free world in which high energy processes have released the particles from their bound states. It might well be that the atomic nucleus is seen to be stable whilst in reality it is in an ever-changing condition as it flips between possible states in which protons, antiprotons, electrons and positrons are exchanging energy as they rearrange themselves as unitary charged quark-like members of that nucleus.

There is, however, no room for alternative hypotheses in physics and such an idea can only be tolerated alongside the traditional neutron-proton nuclear model if it has a very clear connection with something that can be measured.

THE STRUCTURE OF THE DEUTERON

To provide this measurable feature, the author notes that more than twenty years ago he had the concept of a deuteron being comprised of two protons or two antiprotons plus just enough electrons or positrons to give the composite particle a single unitary positive net charge. The object of the analysis was (a) to decide which combination of such charges had the least net mass, allowing for the mass-energy of the Coulomb action binding the charges together and (b) to estimate how much energy would be needed to drive the particles well apart and so isolate a residual proton (or antiproton plus two positrons), whereby to work out how much energy was needed to create a neutron by-product.

The least energy form of the deuteron was definitely found to be one comprising an in-line configuration of three positrons with two antiprotons, each positioned between two positrons. The interesting point, however, was that if these five component particles were torn asunder by a powerful energy input, the energy needed to fully overcome the Coulomb action matched very closely that needed to transform a deuteron into a proton and eject a neutron. The analysis depended only upon use of the classical formula used by J. J. Thomson to determine the finite form of the electron radis, namely 2/3 of what is today termed the 'classical radius of the electron'.

It proved impossible to publish this result in an establishment periodical because the electrons were deemed by referees in those days to be point charges and nuclear physicists did not want to picture their presence or those of positrons in an atomic nucleus, even though atomic nuclei have dimensions commensurate with that classical electron radius. The author had to be content by disclosing it in a book [2], but at least it was put on record in 1969 and later in 1980 in a newly titled update of that earlier work [3].

The major advance, however, from this pursuit emerged when the theory of the deuteron was fully developed to give a precise account of its magnetic moment as measured by reference to the proton. Here one had a quantity known to one part in a million precision and this was an identifying number which, if deciphered correctly, would reveal the precise form of the deuteron.

WHAT IS A NEUTRON?

The neutron, however, provided the clue to discovering a route to a solution. The author had reason for envisaging the neutron as cycling between different neutral states. The question to resolve was how long it would spend in each possible state before restructuring, as by electron-positron creation or annihilation in its field entourage. The neutron has a mass that is greater than that of the proton by slightly more than 2.5 electron masses and it has a response in a magnetic field as if whatever reacts has a magnetic moment which reveals that the neutron is really negatively charged for most of the time.

It requires very little imagination to see that the neutron is probably comprised of an antiproton at its core that is surrounded by an electron-positron field of one positron plus one, two, or even three electron-positron paris to make up that extra mass when in linear motion, while its core responds in its gyromagnetic action as a true antiproton for most of the time.

There were four possible configurations that seemed possible and the chance of transition was deemed to be a function of the electron and positron constituent populations. It was a deciphering or code-breaking problem to figure out the odds governing the presence of each state. One state was a ground state in which the core charge was truly neutral, comprising simply an antiproton and a positron bound together. The question was how one could be sure that all the possibilities for other states had been factored into the analysis. How could one be sure that the four most likely states were the true states and that the neutron was not activated in what could be shown to be restricted to five or some other number of least energy (and so most likely) states?

Here, there was a verifying condition. The theory had first to yield the precise mass of the neutron, or rather the mass increment of the neutron over that of the proton. Then, it faced the other test, that of explaining the magnetic moment.

On the mass test, the theory gave a perfect result. It was found that the neutron had four states and in any period of 23 time units it would spend 17, 3, 2, and 1 time units respectively in each state. The first and most populated state was that of least energy. The neutron had a core antiproton with one satellite electron-positron bound pair plus one free positron. The least populated state, the fourth state, was the truly neutral core state. As just stated, the neutron mass calculated from this model checked exactly with that derived from precision measurements data. **The fantastic discovery, however, was that the magnetic moment was in almost unbelievably precise accord with that recorded from measurement.** The theory said that the magnetic moment of the neutron had to be, allowing for a g-factor of 2, precisely 44/23 nuclear magnetons, which is 1.913043478. The measured value of this quantity [4] is known to 2 parts in ten million and is 1.91304308 54. It can be seen that the theory fits the measured value within one standard deviation in spite of this exacting accuracy. This fact is, in this author's view, proof positive that the neutron has the form which deciphering by a 4-state model has indicated.

Readers will understand why this author can assert that there are no neutrons in a deuteron as soon as the structure of the deuteron is similarly deciphered. The neutron has four states and spends its short lifetime flipping among those four states. That lifetime is calculable from the same model, as one can see in the primary paper in which this whole theory was presented in 1986 [5]. In all those states, its main nucleon constituent is an antiproton. Under no circumstances can one contemplate that a deuteron contains a neutron when one finds by similar analysis in onward research that the deuteron alternates between only three states.

Just as the neutron, though neutral, exhibits a magnetic moment as it has a negative electric charge for all but 1/23 of the time, so the deuteron, though positively charged, does not exhibit a magnetic moment corresponding fully to its positive charge. Analysis shows that in any period of 7 time units the deuteron spends 4, 2, and 1 time unit is its respective states and the latter single period state is that in which its core charge is neutral. The form of the deuteron in each of these states is shown in TABLE II of reference [5] and bears no resemblance to any of the neutron states presented in TABLE I of that same reference. Thus the deuteron has a magnetic moment that corresponds to a 6/7 factor complicated, however, as to its mass, by the fact that when the deuteron core is charged it is not a simple proton charge but that of two charged nucleons (whether proton or antiproton) bound by electrons or positrons. Thus, although full theoretical analysis yields the part in a million precision for this magnetic moment, the 6/7 factor of 0.85714 is only a rough approximation of the measured value of 0.857438 nuclear magnetons.

NO-NEUTRON DEUTERON FUSION

What is meant by the fusion of deuterons with no neutrons should now be clear in the context of 'cold fusion'. The neutron problem is irrelevant. If the deuteron does not contain neutrons and there is no high energy activity to create them, then neutrons cannot exist as a primary product of cold deuteron fusion. We may ask, "Why should two charged deuterons ever react by coming close enough to fuse together and release energy?" The answer is, of course, a matter for further research aided by speculation. The fact is that cold fusion appears to happen. What can be stated, however, is that if the deuteron core is neutral for 1/7 of any period of time by virtue of a satellite presence of a positron, then the task of bringing two deuterons close enough to merge is simply that of immobilizing those positrons. Positrons are immobilized by electrons which are happy to annihilate them even though their combined energy merely goes into a reincarnation of an electron - positron pair elsewhere in the field. Such annihilation would also trigger a change of state to a deuteron form with a charged core, if two deuterons had not been triggered into fusion first. Therefore, since Fleischmann and Pons [1] in their research find that an electron current flow through a cathode impregnated with deuterons in close proximity stimulates a fusion reaction, then that can possibly be seen as verifying the author's theory of the deuteron state.

Time, however, will tell whether some extra energy stimulus is needed to supplement the extraneous electron presence in the cathode conductor. The author has indulged in a little speculation on this very cold fusion theme elsewhere [6], based on theory stemming from the work already described here. The energy stimulus could be sourced in the vacuum zero-point energy and stimulated by a resonance effect that matches the palladium cathode atomic mass. However, that is a future story.

What this author will never understand is the presumption in nuclear physics that the electron and positron cannot be present in an atomic nucleus, when beta emission, positive and negative, is so much in evidence. One needs only to admit that possibility to discount the need for neutrons in an atomic nucleus. If the argument is that electrons and positrons are created in nuclear decay but not present in a stable nucleus, then the argument should apply equally to neutrons.

Nor will the author ever understand why establishment research laboratories bother to measure the proton-electron mass ratio or the neutron magnetic moment to part in ten million precision, if it is not to provide a challenge for the theoretical physicist. However, one must then wonder why those funding theoretical research choose to ignore a successful method such as that disclosed here, and persist in their mainstream belief in quantum chromodynamics.

It takes a real experimental discovery to break through the established beliefs, but it is, indeed, of real concern when such a discovery, once made, is rejected primarily on the basis of those beliefs. It is absurd to imagine that the centuries ahead will not witness major revision in those many aspects of science which depend, if only partially, upon hypotheses which have become a religion rather than tentative guides until overtaken by experiment.

Establishing the true facts underlying the physics of cold fusion has major importance, not only for our energy technology in the immediate future but also to awaken an attitude of tolerance and responsiveness to non-conformist but enlightened progress in science and technology.

The key reference relied upon above is reference [5]. The Hadronic Journal is published by the Institute for Basic Research, Harvard Grounds, 96 Prescott Street, Cambridge, Massachusetts 02138. (Tel: 617/864-9859). It is a journal that warrants favor and support because it is a well-refereed journal open to new and sound basic ideas even if they do question orthodox but unproven beliefs whether in particle physics or concerning the theory of relativity.

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[2] H. Aspden, "Physics without Einstein", Sabberton, P.O. Box 35, Southampton, England) 1969. See pages 128-129 on "The Deuteron Reaction" in Chapter 7 on "Nuclear Theory".

[3] H. Aspden, "Physics Unified", Sabberton, P.O. Box 35, Southampton, England) 1980. See pages 122-128 on "The Deuteron" in Chapter 7 on "Particles of Matter".

[4] G.L. Greene, et al, "Determination of the Neutron Magnetic Moment" in "Precision Measurement and Fundamental Constants II", B.N. Taylor and W.D. Phillips, Eds., U. S. Natl. Bur. Stand. Spec., Publication 617, pages 233-236, 1984.

[5] H. Aspden, "The Theoretical Nature of the Neutron and the Deuteron", Hadronic Journal, Vol 9, pages 129-136, 1986.

[6] H. Aspden, "The Supergraviton and its Technological Connection", Spec. Sc. Tech. Vol. 12, pages 179-185, 1989.

ABOUT THE AUTHOR.

Dr. Harold Aspden became a Visiting Senior Research Fellow at Southampton University in England in 1983 upon his early retirement from IBM. He spent the last 19 years of IBM service as Director of IBM's European Patent Operations. He is a Fellow of the Institution of Electrical Engineers and of the Institution of Mechanical Engineers in U.K. and a Member of the U.K. Institute of Physics. His primary research interest is in electrodynamic interactions involving matter and the structure of the vacuum state, which includes gravitational phenomena. His Ph.D. from Cambridge in England is for experimental research on magnetism and dates from 1954.

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C. FUSION NEWS FROM U.S.

WALL STREET JOURNAL RESURRECTS COLD FUSION

Jerry E. Bishop, "'Cold Fusion' Research Dispels Some Doubts", Wall Street Journal, page B-1, March 2, 1990.

Bishop leads with "The mystery of 'cold fusion' hasn't been solved, but a growing number of experiments suggest that the phenomenon can't be written off as a scientific error."

Bishop cites work at BARC in India, Los Alamos National Laboratory, Texas A&M, Case Western Reserve, and Oak Ridge National Laboratory. Dr. David Worledge of EPRI in Palo Alto, Calif. is also quoted. Mention was made that the Department of Energy quit funding cold fusion experiments but that EPRI expects to provide $1 to $2 million in continued research funds in 1990.

Drs. Charles Scott (Oak Ridge National Laboratory), Robert A. Huggins (Stanford), and John O'M. Bockris (Texas A&M) are cited in a short discussion of excess heat. Bockris is quoted as saying, "There's no doubt about the existence of an effect." and continued by adding that it is a nuclear reaction of some sort.

The article reports that Pons and Fleischmann have submitted a voluminous (more than 100 pages) report to the Journal of Electroanalytical Chemistry. [Dr. Pons office has not received a date for publication. Ed.]

Note: We welcome Jerry Bishop and his prestigious paper to the fusion club. This article should greatly increase the interest in solid-state fusion by corporate entities in the U.S. U.S. researchers may yet catch up with funding levels being provided to scientists in Japan and India by their governments and their corporations. Little thanks to the DoE who recently removed funds pledged to cold fusion development.

FUSION - BULK VERSUS SURFACE

Vern C. Rogers, Gary M. Sandquist, Kirk K. Nielson, (Rogers and Assoc. SLC, UT.), "Deuterium concentration and cold fusion rate distributions in palladium", Fusion Technology, vol 16, no. 4, pages 523-525, 1989.
This article provides solutions to equations that would show that the hypothesis for d-d fusion to occur predominantly at the palladium surface is not consistent with the experimental findings.

DEMISE OF COLD FUSION PREMATURE

"Electron-Doped Superconductors Gain Attention; Cold Fusion Papers Prompt Much Talk, Few Results", Science Watch, Vol. 1 No. 1, January 1990, pg 6.

This new publication from the Philadelphia-based Institute for Scientific Information lists the ten most frequently quoted scientific papers (published since early 1988). Eight of the ten deal with superconductivity. The other two are Fleischmann, Pons and Hawkins [1] which ranks as the second most quoted; and Jones et al [2] which ranks as sixth most quoted paper.

The article states: "Lack of confirmations has convinced all but a few that the phenomenon reported was chimeric, perhaps an artifact of the experimental technique used. ... In the last issue Science Watch predicted that this continuing lack of confirmation would cause the Pons and Fleischmann article to drop off the list. Instead, it has now risen from fifth to second spot, and the paper by Jones et al. has entered the list for the first time (#6). ... Obviously, Science Watch was premature in its prediction but, one wonders, how much longer will the publication of negative results go on before scientists move on to something else."

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[1] M. Fleischmann, S. Pons, and M. Hawkins, "Electrochemically induced nuclear fusion of deuterium." J. Electroanal. Chem., 261, pp 301-308, and erratum, 263, p 187 (1989).

[2] S. E. Jones, E. P. Palmer, J. B. Czirr, D. L. Decker, G. L. Jensen, J. M. Thorne, S. F. Taylor, and J. Rafelski, "Observation of cold nuclear fusion in condensed matter.", Nature, 338, pp 737-740 (1989).

Note: We have sent Science Watch the latest copy of Fusion Facts and have suggested that there are more positive and less negative papers with each passing month. Ed.

ARGONNE NATIONAL LABORATORY
(Courtesy of Dr. Samuel Faile)

S. Freedman and D. Krakauer, "Biases in cold fusion data", and "Jones, et al reply", Nature, vol 343, pages 703-704, 6 refs.

Freedman and Krakauer speculate that Jones et al may have statistical biases in cold fusion data. Jones, et al provide sufficient comment giving further details of experimental data to show that data is correct and not biased. [These comments show the difficulty that occurs with trying to prove/disprove solid-state fusion based on neutron emission. Ed.]

BROOKHAVEN NATIONAL LABORATORY

Harold Wiesmann (Dept of Applied Science), "Examination of Cathodically Charged Palladium Electrodes for Excess Heat, Neutron Emission, or Tritium Production", Fusion Technology, Vol 17, March 1990, pages 350-357, 7 refs.

Note: This paper was submitted for publication October 2, 1989 prior to the flood of positive papers replicating the Fleischmann-Pons discovery. Ed.

Dr. Weismann presents the three deuteron fusion reactions that produce (1) helium 3 and neutrons, (2) Tritium and protons, and (3) Helium 4 and comments: "Reactions (1) and (2) occur with about equal probability, but reaction (3) is suppressed by about six orders of magnitude." The author found no compelling evidence in his experiments for any of the three reactions.

Note: We suggest that Dr. Weismann visit with Dr. James McBreen of Brookhaven National Laboratory who reported measuring tritium and excess heat. Dr. McBreen wryly observed when asked about his pursuit of funding support, "No. I didn't try. It was like a lot of people undergo personality transformations when you discuss this topic. So I didn't try." [Quotes from transcript of interview with Dr. McBreen KSL-TV, January 23, 1990. Ed.]

NAVAL RESEARCH

MEASURING HYDROGEN INTO HYDRIDE
(Courtesy of Dr. Samuel Faile).

Graham T. Cheek (US Naval Academy) and William E. O'Grady (Naval Research Laboratory, "Measurement of hydrogen uptake by palladium using a quartz crystal microbalance", J. Electroanal. Chem. vol 277, 1990, pages 341-346, 15 refs.

Note: Article may be of some interest to cold-fusion researchers as a possible method to measure the degree of deuteridization in a host metal lattice. Ed.

CALIFORNIA - BERKELEY
FRACTO-FUSION
(Courtesy of Dr. Samuel Faile)

P.B. Price (Physics Dept.) "Search for high-energy ions from fracture of LiD crystals", Nature, vol 343, 8 February 1990, pages 542-544, 18 refs.

Negative results in trying a replication of previous work on fusion occurring by fracture.

CALIFORNIA - EPRI AT PALO ALTO

Mario Rabinowitz and David H. Worledge (Electric Power Research Institute), "An Analysis of Cold and Lukewarm Fusion", **Fusion Technology**, Vol 17, March 1990, pages 344-349, 25 ref.

Abstract: Experimental reports continue to suggest that the crystalline solid state may present a unique environment for deuteron-deuteron fusion at ambient temperature (cold fusion). The analysis herein shows that newly reported cluster-impact d-d fusion at energies approx 100 eV has much in common with cold fusion and might appropriately be called lukewarm fusion. Both phenomena evidently need a novel theoretical approach for their understanding. A deuteron effective mass approach is proposed as a possible explanation of the reported experimental results.

The authors contrast the unacceptance of the Fleischmann-Pons report of cold fusion with the ready acceptance of low-energy cluster-impact fusion as a scientific fact. [A reasonable definition of a scientific fact is "the close agreement of a reproducible series of observations of the same phenomena." Implied would be "by one skilled in the art". Ed]

The authors provide a general derivation of the fusion rate to be expected in a solid. The paper continues with a discussion of how the effective mass of a deuteron may be reduced in the crystal lattice. The discussion leads to the prediction for the model that "heavy loading of the lattice with tritons and deuterons should give even higher fusion rates".

Unlike many theory papers, the authors deal not only with the deuterons situated within the potential wells in the crystal lattice but also with the "hopping" deuteron that is in transit between interstitial sites.

The authors note: "In addition to accounting for reported fusion rates, this theory further predicts two generic properties of cold fusion in the bulk of a solid:

1. There is an extremely strong dependence on deuteron concentration, as reflected in the results for decreasing R.

2. There is not a strong temperature dependence of the fusion rate right up to the melting point. For palladium this is 1828 K, corresponding to E = 0.152 eV.

The authors also note: "The relevance of the Beuhler et al experiments (Cluster-Impact Fusion) to cold fusion goes beyond the apparent need for a novel concept to explain the fusion rates. There are tantalizing indications in these experiments that the ratio between the neutron and proton branches of the d-d reaction may be much smaller than unity. This is similar to the inference obtained in cold fusion from observation of neutron to triton yields in electrolytic cells."

[Note: The fact that tritium production in cold fusion electrochemical cells is highly favored over neutron production is so important to the understanding of cold fusion that the reader should also review the following paper which was covered in the February 1990 issue of Fusion Facts:

Gary S. Chulick, Yeong E. Kim, and Robert A. Rice (all from Purdue), "Low Energy D-D Fusion Experimental Cross-Sections", A paper submitted to the First Annual Conference on Cold Fusion, Salt Lake City, Utah, March 27-30, 1990.

ABSTRACT: A major criticism of electrochemical fusion experiments has been that the extracted deuterium-deuterium (D-D) reaction rates from these experiments are 40-50 orders of magnitude larger than the calculated reaction rates. However, the reaction rate calculations are partly based on the assumption that the D-D reaction cross-section at extremely low energies (i.e., a few eV) is of correct form. Since the D-D cross-section has not been measured at energies below 2 keV (center-of-mass), it is naively assumed that the trends in the cross-section above that energy are automatically valid below that energy. Close examination of the available lowest energy D-D cross-section data, and the results of the recent Brookhaven cluster fusion experiment, which potentially allows us to extract the D-D cross-section down to the eV range, indicate that this assumption is not valid. The low energy cross-section (approx. 100 eV) appears to be 10-20 orders of magnitude larger and appears to behave differently than the cross-section at higher energies.]

IOWA STATE UNIVERSITY

Bernard I. Spinrad (Dept of Nuclear Energy), "On Cold Fusion", Fusion Technology, Vol 17, March 1990, page 343, 1 ref.

Abstract: A conjecture is presented that a high negative voltage on a metal into which deuterium is soaked might enhance

fusion reactions. This may have been the way Fleischmann and Pons achieved their remarkable results.

Spinrad speculates: "One can achieve a very respectable density of deuterium in metals such as palladium, and the resulting hydride, nevertheless, remains a good conductor of electricity. Since it is a good conductor, it can be charged to a high electrical potential. Bringing the material to a high negative potential puts many electrons into the cell. A high density of pervasive negative charge should be just as effective as high-mass negative charges in permitting close approach of two deuterons to each other."

The article suggests that if a metal deuteride sample is charged to -10 kV that the repulsive region around a deuteron is reduced by a factor of 1000. The author suggests a recipe for solid-state fusion: Place palladium deuteride on a highly negatively-charged plate and stand back.

PURDUE UNIVERSITY

HIGH VOLTAGE FUSION
(Courtesy of Dr. Yeong E. Kim, Dept. of Physics)

Yeong E. Kim, "Neutron Burst from High Voltage Discharge Between Palladium Electrodes in D2 Gas", Dept. of Physics Paper PNTG-90-6, February 1990, 8 pages, 5 refs.

Abstract: A recent experimental observation (Wada & Nishizawa Japan) of a neutron flux burst at a rate of 2 x 10^4 times the background rate immediately following a high voltage discharge between two deuterated palladium electrodes in D_2 gas is explained in terms of the experimentally measured deuterium-deuterium fusion cross sections.

PROTON-DEUTERON FUSION
(Courtesy of Dr. Yeong E. Kim, Dept. of Physics)

Yeong E. Kim, Robert A. Rice, and Gary S. Chulick, "The Role of the Low-Energy Proton-Deuteron Fusion Cross-Section in Physical Processes", Dept. of Physics Paper PNTG-90-7, February 1990, 18 pages, 26 refs.

Abstract: We calculate the p-D fusion reaction rate at low energies (E < 2 keV in the center of mass frame) for a Maxwell-Boltzmann velocity distribution and compare it to that for other reactions involving hydrogen isotopes. It is shown that p-D fusion dominates the other reactions for E less than 8eV in the center of mass frame. The implications for various physical processes are discussed.

The summary of the article has the following:

"It is shown that the low-energy p-D fusion rate, Lambda (E_{pD}), calculated with a Maxwell-Boltzmann velocity distribution is larger than other fusion rates for D(D,p)^{3}H, D(D,n)^{3}He, D(D, Gamma)^4 He, ^{3}H(p, Gamma)^{4}He, and ^{3}H(D,n)^{4}He at CM energies below 8 eV. If the conventional extrapolation used turns out to be unreliable and underestimates the fusion cross section as implied by recent indirect measurements of the D-D fusion rate at low energies the p-D fusion process could provide a plausible explanation (i) for the recent results of electrolysis fusion experiments (together with the D-D fusion reaction and (ii) for the earth's internal heating.

LETTERS FROM READERS.

REPUBLIC OF SOUTH AFRICA

In answer to our queries about interest in solid-state fusion, Mrs. H. Althea Bell of the South African Science and Technology Office of the South African Embassy sent us the following from the Atomic Energy Council in South Africa:

"i. we have a relatively large scale experimental program which has seen many 'excursions' which closely resembled Cold Fusion events, but which on close scrutiny and proper analysis have been artifacts and that to date we have nothing positive to report except upper limits.

"ii. we maintain close contact with all theory and new data available world wide through publication as well as through personal contact.

"iii. the contents of Fusion Facts add to this plethora of reporting and represents a useful input to our reviewing procedure."

For those interested, the contact is:
Dr. Don Mingay

Atomic Energy Corporation of South Africa Limited
Nuclear Research and Development Group
P. O. Box 582
0001 PRETORIA, REPUBLIC OF SOUTH AFRICA

ENGLAND

Dr. H Aspden, Dept. of Electrical Engineering, The University, Southampton makes the following interesting comments on cold fusion patents: "... the use of the 'perpetual motion' argument against cold fusion is not justified if used by a patent examiner because there is no contravention of energy conservation laws nor natural laws. After all, once the deuterium is spent the reaction must stop. However, if the examiner is inundated by patent applications in a field which the establishment declare is futile then who knows how he or she might react to ease the patent processing load?"

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D. FUSION NEWS FROM ABROAD

FROM AUSTRIA

FEASIBILITY DISCUSSION

S. Fujita, (Inst. Theor. Phys., U. Graz, Austria), "On the feasibility of nuclear fusion in fcc metals", Phys. Status Solidi B, vol 156, no. 1, pages K17-K21, 1989, in English.

The feasibility of nuclear fusion in face-centered cubic metal lattices is discussed in terms of previous work on the theory of diffusion (Fe and coworkers, 1987-1988).

FROM DENMARK

Bent Elbek, "Cold Fusion?", Gamma (Copenhagen), vol 76, pages 19-21, 1989 (In Danish), 2 refs. [Cold fusion status is reviewed and it is postulated that a nuclear process has not been proven.]

FROM FEDERAL REPUBLIC OF GERMANY

KARLSRUHE CONFERENCE

Greg Cripps (Kernforschungzentrum Karlsruhe, Institute for Nuclear Physics and Reactor Technology), "Summary of the Fifth International Conference on Emerging Nuclear Energy Systems, Karlsruhe, Federal Republic of Germany, July 3-6, 1989)" Fusion Technology, Vol 17, March 1990, pages 356-359.

This report summarizes papers on cold fusion that were presented at the conference. Organizations that had confirmed neutron bursts from deuterium-loaded metals included: BYU, LANL with U. of Arizona, BARC (India), Ruder Boskovic Institute (Yugoslavia), Ben Gurion Univ (Poland), and Royal Institute of Technology (Sweden). The report concludes with the following:

"At the initiative of the session chairman A. A. Harms (McMaster University), the following list of observed phenomena and possible explanations was made up and circulated:

"Observed
1. intermittent/sporadic neutron emission.
2. spatially localized?

"Possible Mechanisms
1. quantum mechanical tunneling enhancement
2. deuteron acceleration across microcracks
3. coerced microexplosions
4. muon catalysis via cosmic background radiation
5. deuteron recoil via neutron background
6. nonequilibrium chaotic dynamics
7. nonsymmetric electron cloud distortion
8. collective waves
9. multibody collisions
10. electron overscreening
11. phase transformation
12. cluster formation
13. superionic conduction
14. microcosmic showers
15. inverse beta decay
16. sequential multibody collisions with screening"

Note: The conference proceedings are published by the World Scientific Publishing Company, Farrer Road, P. O. Box 128, Singapore 9128.

ANOTHER NEGATIVE REPORT

J. Divisek and L. Furst (Institute of Applied Phys Chem, Nuclear Research Centre, Julich), "Energy balance of D2O electrolysis with a palladium cathode. Part I. Theoretical relations. Part II. Experimental." J. Electroanal Chem., vol

278, 1989, pages 85-117, 40 refs., English. This lengthy paper submitted 4 Sept 1989 is of interest only to demonstrate that the authors were not successful. It is obvious that they need some help in operating a successful Fleischmann-Pons Experiment.

FROM FRANCE

NEGATIVE FINDINGS ON NEUTRONS
(Courtesy of Dr. Samuel Faile)

F. Botter, J. Bouchez, J. Collot, E. Kajfasz, B. Lefievre, E. Lesquoy, A. Stutz, S. Tistchenko, S. Zylberajch (Dep. Etude Lasers Phys. Chim., CEN-Saclay, Gif-sur-Yvette, France), "Search for emission of neutrons from a palladium-deuterium system", Phys. Letters B, 1989, vol 232, no. 4, pages 536-538, in English, 6 refs.

Abstract: Limits have been set on neutron production from the palladium-deuterium system. These limits are several orders of magnitude lower than previously reported results in the titanium-deuterium system.

FROM INDIA

SCREENING-ENHANCED FUSION
(Courtesy of Dr. Samuel Faile)

S.N. Vaidya and Y.S. Mayya (BARC, India), "Theory of Screening-Enhanced D-D Fusion in Metals", Japanese Journal of Applied Physics, Vol 28, No. 12, Dec 1989, pp L2258-L2260, 12 refs., in English.

Abstract: The enhancement of d-d fusion rates in metals brought about by the combined screening of electrostatic interactions by the conduction electrons and mobile deuterons, is investigated using the jellium model. It is assumed that under electrolytic conditions, deuterium exists as itinerant deuterons in metals such a palladium. We derive an expression for the screening constant treating electrons as fermions and deuterons as bosons. The screening by charged bosons is a novel concept and is found to be sensitively dependent upon the temperature. The d-d fusion rate is found to increase substantially when the electron-deuteron screening of the Coulomb barrier is incorporated.

Note: See also Fusion Facts, February 1990, page 14 where this article is reviewed as a part of the 20-page BARC publication. Ed.

EXCESS HEAT FROM TITANIUM
(Courtesy of Ramtanu Maitra, New Delhi)

K.S.V. Santhanam, J. Rangarajan, O'Neil Braganza, S.K. Haram, N.M. Dimaye, and K.C. Mandal (Tata Institute of Fundamental Research, Bombay), "Electrochemically initiated cold fusion of deuterium", Indian Journal of Technology, Vol 27, pages 175-177, April 1989, 11 refs. [Paper received 25 April 1989]

Abstract: It is demonstrated that during the electrolysis of D_2O at titanium cathode and platinum anode excess enthalpy is generated; this excess enthalpy is attributed to a possible nuclear fusion process involving deuterium atoms. During the electrolysis excess heat of 17% is obtained; a total of 0.2 MJ/cm^3 of electrode volume is reached for the first time over an experimental period of 48 h at Ti cathode.

The authors provide a comparison between excess energy using a titanium cathode and excess energy using a palladium cathode. In the short time span between the Fleischmann-Pons announcement (March 23, 1989) and the time this paper was submitted for publication (April 25, 1989), the authors had apparently replicated the Fleischmann-Pons Effect using both Titanium and Palladium. The amount of excess heat reported is about 17% for titanium and about 48% for palladium. These figures convert into about 0.1 watts per cubic cm for titanium to about 6.8 watts per cubic cm for palladium.

WORK AT INDIRA GANDHI CENTRE

C.K. Mathews, G. Periaswami, K.C. Srinivan, I. Gnanarsekatan, S. Rajan Babu, C. Ramesh, and B. Bhavagarajan (Radiochemistry Programme, Indira Gandhi Centre for Atomic Research, Kalpakkam), "On the possibility of nuclear fusion by the electrolysis of heavy water", Indian Journal of Technology, Vol 27, pages 229-231, May 1989, 2 refs.
[Paper received 1 May 1989]

Abstract: Experiments conducted to confirm the occurrence of nuclear fusion during the electrolysis of heavy water indicate that neutrons are emitted during the electrolysis of D_20 with a titanium cathode and platinum anode. The temperature rise

at the cathode in the electrolysis of D_2O using a palladium cathode is twice that seen in the electrolysis of H_2O under identical conditions. The heat liberated is far in excess of the estimated energy release by assuming that every neutron emitted corresponds to a fusion event.

Note: Our apologies for not bringing these two papers to the attention of our readers before now. These papers certainly should have some historic interest and also demonstrate how quickly the Indian scientists were able to replicate and improve on the Fleischmann-Pons experiment. Ed.

FROM JAPAN

METAL-HYDROGEN SYSTEM
(Courtesy Dr. Samuel Faile)

I. Yamamoto, M. Yamaguchi, T. Kobayashi (Yokohama Nat'l U.), T. Goto (U. of Tokyo), S. Miura, and I. Mogi (Tohoku U.), "Pressure-Composition Isotherm in a Magnetic Field for the Metal-Hydrogen System", Japanese Journal of Applied Physics, Vol 28, No. 12, Dec 1989, pp 2629-2630, 4 refs., in English.

Abstract: The pressure-composition isotherm under the influence of a magnetic field has been observed for the first time using the $LaCo_5$-H system at 273.2 K in 12 Tesla magnetic field.

Note: This reference may give some ideas for the measurement of metal/deuterium ratio in fusion cells. Ed.

FROM NETHERLANDS

LITHIUM NUCLEAR CROSS SECTIONS
(Courtesy of Dr. Samuel P. Faile)
J.B.J.M. Lanen, R.G. Lovas, A.T. Kruppa, H.P. Blok, J.F.J. Vand den Brand, R. Ent, E. Jans, G.J. Kramer, L. Lapikas, et al, (Rijksuniv. Utrecht), "An (e,e'p) study of triton + deuteron + proton clustering in lithium-6", Phys. Rev. Lett. vol 63, no. 26, pages 2793-2796, in English.

The nuclear cross sections for the ^{6}Li(e,e'p) reaction were measured in the energy region greater than the t + d level. The 3/2+ resonance dominates this region. Data are compared with calculations involving the cluster-distortion model with distorted-wave impulse-approximations. [This paper may have some bearing on possible lithium reactions in some solid state fusion cells. Ed.]

MODEL FOR HYDROGEN DIFFUSION IN Pd
(Courtesy Dr. Samuel Faile)

E. Salomons (Natuurkundig Laboratorium, Vrije Universiteit, Amsterdam), "On the lattice gas description of hydrogen in palladium: a molecular dynamics study", Journal Physics, Condensed Matter, Vol 2, pages 845-855, 1990, 18 refs.

Abstract: The occupation by hydrogen of octahedral and tetrahedral sites in palladium are determined with the simulation model of Gillan. They are in agreement with the predictions of a lattice gas model. The effect of lattice relaxation on the octahedral site energies of hydrogen in palladium alloys is investigated with the damped molecular dynamics technique. The diffusion coefficients of hydrogen in palladium, as determined from the simulations, are used to construct a useful random-walk model for the calculation of diffusion coefficients.

The conclusion states: The diffusion coefficient of hydrogen in palladium has been compared with the predictions of the correlated walk model of Fujita and Neugebauer (1988). It turned out that this model reduces in good approximation to a simple random-walk model for hydrogen in palladium.

HYDROGEN ABSORPTION IN $Pd_{91}Y_9$

E. Salomons, N. Koeman, J. Rector, and R. Griessen (Natuurkundig Laboratorium, Vrije Universiteit, Amsterdam), "Short-range order parameter of the disordered alloy $Pd_{91}Y_9$ determined from hydrogen absorption", Journal Physics: Condensed Matter, vol 2, 1990, pages 835-844, 26 refs.

Abstract: Experimental pressure-composition isotherms of hydrogen absorption in the disordered alloy $Pd_{91}Y_9$ have been measured. The isotherms are found to be considerably changed after annealing the sample in a hydrogen atmosphere. This effect is explained quantitatively by the fact that, during the anneal, interstitial hydrogen eliminates the short-range order present in the host metal $Pd_{91}Y_9$. The isotherms are fitted by a lattice gas model, using Monte Carlo data for the distribution of metal atoms in an alloy with short-range order.

HYDROGEN IN PALLADIUM ALLOYS

E. Salomons, H. Hemmes, and R. Griessen (Natuurkundig Laboratorium, Vrije Universiteit, Amsterdam), "Hydrogen Spectroscopy of $Pd_{1-y}Ag_y$ and $Pd_{1-y}Cu_y$ Alloys", Jrnl Phys: Condensed Matter, vol 2, 1990, pages 817-834, 35 refs.

Abstract: Thermodynamic data for hydrogen absorption in palladium silver and palladium copper alloys, including pressure-composition isotherms and enthalpies and excess entropies of solution, are described by a multi-site lattice gas model. The distributions of site energies of hydrogen in these alloys are obtained by fitting to the data. It is found that the site energy at an octahedral site is not a linear function of the index i. It is suggested that this non-linear behavior originates from a local electronic effect related to the filling of the palladium d band by Ag or Cu electrons.

FROM RUSSIA

FAST NEUTRONS FROM Pd-D_2O-T_2O SYSTEM

V.D. Rusov, T.N. Zelentsova, M.Yu. Semenov, I.V. Radin, Y.F. Babikova, Yu.A. Kruglyak (Odess. Gos. Univ), "Fast neutron recording by dielectric track detectors in a palladium-deuterated water-tritiated water system in an electrolytic cell", Pis'ma Zh. Tekh. Fiz., vol 15, No. 19, pages 9-13 (In Russian).

Instrumentation was used to record the integrated flux of neutrons from possible cold nuclear fusion of light nuclei in an electrolytic cell using a Pd corrugated alloy, heavy water, and tritiated water. Rare events were recorded resulting from destruction of the C nucleus and attest to the presence in the spectra of fast neutrons with energy greater than 10 MeV.

FROM SPAIN

THEORY ON SCREENING EFFECTS

Nestor R. Arista, A. Gras-Marti, R.A. Baragiola (Univ of Alacant), "Screening effects in nuclear fusion of hydrogen isotopes in dense media", Phys. Rev. A: Gen. Physics, Vol 40, No. 12, pages 6873-6878, 1989, English.

Nuclear fusion rates are calculated for various isotopes of hydrogen embedded in a dense screening media. For qualitative estimates of the screening in solids, a Thomas-Fermi description is used of the electron diffusion. A crossover of the fusion rates of the various isotopic pairs are analyzed. Fusion rates for p-d, d-d, p-t, and d-t are made for increasing screening length, velocity, or effective temperature of the medium. Results are compared with previous experimental and theoretical studies.

FROM SWITZERLAND

DECLINE OF COLD FUSION

Douglas Morrison (CERN), "The rise and decline of cold fusion" Physics World, February 1990, pages 35-38, no references.

An entertaining report on the "pathological science" of cold fusion. An excellent example on how one can select sources and report non-events. On the bright side Morrison reports that "It is hard to prove or disprove such claims [bursts of heat] and many neutral people feel that some interesting physics might come out of further careful peer-reviewed studies." On the uninformed side, Morrison makes the following statement: "If the Texas A&M findings were correct [about tritium measurements], enormous rates of neutrons **should have been produced (since the rates of reactions (1) [neutrons] and (2) [tritium] are known to be equal and these are not observed.**"

FROM YUGOSLAVIA AND CANADA

GLASSY-METALS AS FUSION HOST?
(Courtesy of Dr. Samuel P. Faile)

L. Vracar (University of Belgrade) and B. E. Conway (University of Ottawa, Canada), "Hydride formation at Ni-containing glassy-metal electrodes during the H_2 evolution reaction in alkaline solutions", J. Electroanal. Chem. vol 277, 1990, pages 253-275, 27 refs.

Abstract: A group of Ni-containing glassy metal alloys that are of interest as electrocatalysts for cathodic hydrogen production in water electrolysis have been examined with regard to the role of hydride formation and the participation of adsorbed H during cathodic H_2 evolution in alkaline solutions. Hydride formation is important as it may determine, in part, the electrocatalytic properties of the alloys at their surfaces, for cathodic H_2

evolution. Characteristic time-dependencies of currents observed near, but negative to the H_2 reversible potential in response to a stepwise change of potential, together with potential-relaxation measurements on open-circuit following current interruption, lead to the conclusion that a three-dimensional hydride is formed in the near-surface region of the metals during the H_2 evolution process.

Note: The following comment from the Introduction is of interest: "Cathodic sorption of H (or D) into metals now has gained a new and major importance on account of recent reports of nuclear fusion amongst hydrogen isotopes in suitable host metal lattices. Host materials, cheaper than Pd, have obvious economic advantages for such processes, when or if they become confirmed."

* * * * * * * *

E. SHORT ARTICLES FROM AUTHORS

A SOLID-STATE FUSION REVIEW

From Dr. Dennis Cravens, Vernon College, Vernon, Texas

GENERAL POINTS

For new readers of this publication or to newcomers to cold fusion, here is a brief list of points you may wish to review. Much more is going on within these cold fusion cells than we are aware of or admit to. For more detail you are directed to the bibliography by Dr. Faile which is available through the Fusion Information Center.

Unfortunately, there is neither a standard design nor a bench mark fusion cell system that has a high degree of reproducibility. Therefore the following observations are from public domain information and represent a starting point for newcomers. The single best approach is to communicate with others working on solid-state fusion.

EXPERIMENTAL IDEAS

1. The cathode-loading process requires at least 48 hours to charge a 0.5 mm Pd wire with D and 70 to 140 days to charge a 5 mm Pd rod. The initial loading must be done slowly to assure a uniform expansion of the metal lattice.

2. Clean the Pd to extract any normal H. For a 0.5 mm wire heat at 950 C under a vacuum of <1 torr for times of at least 1 hour while cooling.

3. Once cleaned do not expose Pd to any H source - such as air.

4. Store the cleaned Pd by fully submerging the rod in D_20 after cleaning. Remember D_20 is hygroscopic and can pick up H_20 from the air.

5. Use at least 99% pure D_20.

6. Avoid carbon contamination of the rod. Clean all parts and do all rinses in D_20.

7. Form the electrolyte directly from Li metal. You should start with 0.1 m LiOD as standard. It is possible that the ^{6}Li may play an important role in some applications.

8. The anode should be either nickel or platinum.

9. Use a current control device (such as a constant current power supply). Keep the charging currents below 60 mA/sq.cm. In general, keep the current below 600 mA/sq.cm. at all times. The power supply current should be well filtered to remove a.c. ripples since rapid changes have been known to cause excessive reactions and explosion.

10. Spot weld the electrodes for connections. Use nickel or platinum wiring to all electrodes.

11. Smooth all corners and edges of electrodes.

12. Start with a concentric arrangement of electrodes. The distances between the electrodes must be uniform and symmetrical to avoid uneven electrical fields.

13. Start by using Pd or Ti for cathodes. The 105 isotope of Pd may be important to some reactions.

14. Be careful of any contamination, especially carbon and hydrocarbons.

15. Use teflon fittings for stoppers and gaskets and avoid grease fittings.

16. Check your progress by determining the D/Pd ratio by weight (or resistance). It

should be in excess of 0.6 and preferably 0.9. You may notice a swelling of the cathode volume during the charging.

17. Start experiments in a water bath near 20 C. Do not allow rapid temperature swings.

18. Use quartz or aluminum oxide glasses and not soft glass. The LiOD may leach out Na, Ca, and B from the glass.

19. The initial charging of the cathode should be at current levels not exceeding 60 mA/sq.cm. Realize the metal lattice will expand as it accommodates a high D/Pd ratio. Some workers have claimed to visually see a change in the size of the electrodes during charging. When you have a set of electrodes charging, it is often the ones that swell the most that give the best results.

20. Large magnetic fields within the cells may cause spin alignment of the deuterons and alter reactions. Some theories indicate that the spin polarization can alter the T and n branching ratios by spin conservation rules.

21. Tritium can be generated from the cells. You should recombine any deuterium gas from the cell to avoid tritium gas contamination. Use wettable fuel cell catalysts for calorimetry work or heated Pt wire to recombine the deuterium gas. Avoid tritium contamination of your lab by recombining the tritium to water and handle with respect until you are sure of the tritium levels.

22. Use autoradiography with X-ray film to screen ratios in metal alloys for their usefulness. IR film can also be used, but you must know how to care for the material and shield against accidental fogging.

23. Avoid sharp edges and rapid changes in current. These cause local magnetic fields within the cell and uneven D loading. Rough edges and non-symmetric geometries are common among cases of runaway reactions.

24. When using electrode poisons, do not exceed concentrations in excess of millimolar amounts.

25. Nickel can also take up H. If Ni is used as the anode, take precaution to clean the Ni as well as the Pd.

THEORETICAL CONCEPTS

1. The system is dynamic and not static. It is not sufficient to calculate reactions based on a static PdD lattice. Instead it seems that mobil or itinerant deuterons are interacting with the stationary members of the lattice or with other mobile deuterons and electron flows within the lattice.

2. The nuclear events may involve extremely low energy deuterons. The known nuclear reactions that occur at energy levels of 6 orders of magnitude larger should not be extrapolated into low energy environments.

3. At low kinetic energy the deuterons can approach each other in ways that result in induced changes within the deuterons. For example, consider the Oppenheimer and Phillips model which sees the deuterons as a bound proton and neutron. The model provides for internal changes within the deuterons which prefers orientations with protons being at the distal portions and the neutrons at the closest point of exchanges. Such configurations would favor the production of tritium and protons over neutrons.

4. Deuteron are Bose particles. They obey Bose statistics and thus prefer collections of similar states instead of fermi statistics which exclude occupations of similar states.

5. The electron clouds in the metal lattice shield the coulombic effects of the deuterons. In addition to the bound electrons, there are a few mobile free electrons since the electrode has a net negative charge.

6. The deuterons are approximately in thermal equilibrium. They do not have a narrow delta function velocity. Instead they are likely to have a Boltzmann (or modified due to Bose statistics) spread of velocity. This spread can be greater than the absolute velocity.

7. The lithium seems to be important to the process (in an unknown manner). This may simply be due to plugging entry sites into the metal lattice and thereby increasing the flow of deuterium in selected regions. Lithium may be important in formation of whiskers on the surface of the electrode. Lithium may also enter into the nuclear transformation. Keep in mind that there are a few scattered reports of results without

Li using either NaOH electrolytes or gas loaded metals.

8. There are reports of run away reactions and explosions. These reports would seem to indicate that reactions can proceed at elevated temperatures and that the elevated temperature may increase the reactions.

9. In narrow channels within metal lattices, the degrees of freedom are reduced. In such conditions large amount of momentum can be exchanged as larger lithium ions strike deuterons from "behind".

10. In the BARC studies, the tritium production scaled as the surface area of the electrode.

11. The ratio of tritium production to neutron production appears to be dependent on the current density.

12. The metal lattice may absorb the decay products. Pd has a non-zero cross section for neutrons and some reports indicate that it may alter its isotopic ratios during the nuclear process (This report has not been independently confirmed).

13. Deuterons should be treated as particles with definite structure, spin, and magnetic moment.

IDEAS TO TRY

1. Selection of alloys - by autoradiography to screen new alloys.

2. Use of large surface areas - Pd can be worked into thin sheets just as gold - try spiral wound sheets of Pd and Au, like foil capacitors. Alternatively, a palladium mesh may be useful.

3. Acoustical studies - fractures in metal generate acoustical signals - try correlating with neutron emissions.

4. Isotopic changes - Pd-105 may go to Pd-106, Li-6 may be converted.

5. Temperature effects - power may be a function of temperature.

6. IR photography - of working cells and loaded alloys

7. Ultrasonic motion - to alter velocity distribution of D.

8. Spin polarization - magnetic fields may alter reactions and branching ratios.

9. Effects of poisons - D/Pd ratios may be altered.

10. Studies of whiskers - microphotography of whisker growth.

11. Non-aqueous electrolytes - deuterated solvents (DMSO?) and lithium electrodes may be tried.

12. Use of tritium - measure power ratios as a function of T/D ratios.

SPECULATIVE LITHIUM REACTIONS
By Dr. Samuel P. Faile, Cincinnati

INTERNAL GENERATION AND CONSUMPTION OF LITHIUM INTERMEDIATES

One of the many possibilities for solid-state cluster fusion is explored in this article. If cluster fusion were to occur in which six deuterons formed carbon 12, the concentrated energy release would be excessive. It is more reasonable to consider a kinetic energy release in the form of reactive particles that would result in a multiple decay event in the solid-state (lattice) environment.

Two excited high speed particles consisting of lithium nuclei might capture electrons in a virtual reaction if there were further energy releases in up-neutroning components of the lattice. For titanium or palladium, further energy could be produced by the up-neutroning of some of the isotopes (such as ^{105}Pd being converted to ^{106}Pd) as the concentrated energy became spread over the lattice.

The lithium formed (by nuclear processes) could disappear via electron capture within a lattice that would release energy during the up-neutroning process. Along with the formation and breakup of lithium, other factors should be considered as being important.

There could be cycles or feedback mechanisms, such as the high speed lithium nuclei in channels forcing the deuterons to fuse more readily by forcing them together during collisions. Also, the energy released through the metal lattice may aid in the capture of electrons by phonon and coherent photon waves.

Following is a speculative simplified reaction:

Step 1. 6 d --> $(^{12}C)_{virtual}$ --> high-speed Li nuclei of 2 ^{6}Li

Step 2. high-speed ^{6}Li + 4 ^{105}Pd --> (d +4n + 4 ^{105}Pd + 2 neutrinos) $_{virtual}$

Step 3 (d +4n + 4 ^{105}Pd + 2 neutrinos)$_{virtual}$ --> d +4 ^{106}Pd + 2 neutrinos + energy.

For a lattice such as hafnium that would not release much energy by up-neutroning, the cluster reaction may stop at an early stage (or go another route). Instead of the lithium being consumed, the lithium could build up throughout the lattice instead of only being found near the surface (close to the heavy-water, lithium deuteroxide electrolyte).

Another speculation is the buildup of carbon or an alternative fragment of carbon such as helium. Of course, it is even possible that there would be no nuclear reaction and no excess heat.
Following are three simplified speculative reactions:

1. 6 d --> $(^{12}C)_{virtual}$ --> high-speed 2 ^{6}Li

2. 6 d --> ^{12}C (final product)

3. 6 d --> $(^{12}C)_{virtual}$ --> 3 ^{4}He

During excess heat generation for a lattice that is not up-neutroned, an experimenter may find an interesting buildup of various nuclear byproducts in the interior of the cathode metal lattice (the ashes from the fuel).

Note: Dr. Faile's speculations should be taken as fuel for thought processes in our collective search for a better understanding of the complex nuclear reactions that appear to be occurring within the palladium lattice. Collectively, we still do not fully understand the role of either lithium or deuterium in the production of excess heat. Either lithium or deuterium or both may be the nuclear fuel(s). Ed.

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F. COMING CONFERENCES ON COLD FUSION

SIXTH INTERNATIONAL CONFERENCE ON EMERGING NUCLEAR ENERGY SYSTEMS.

This Conference will be held in 1991 in California.

THE FIRST ANNUAL CONFERENCE ON COLD FUSION
UNIVERSITY PARK HOTEL
SALT LAKE CITY, UTAH
MARCH 28-31, 1990

This conference is sponsored by the National Cold Fusion Institute. Advance registration is preferred. Registration for the conference shall be limited to 200 participants and will be accepted on a first-come first-served basis. The fee for the slots that are still available will be $265. Cost includes the proceedings to be published after the conference.

For conference information or registration:

Phone 801/466-3500; Fax 801/466-9616.
Write: Katharine C. Blosch, PMMI
640 E. Wilmington Ave.,
Salt Lake City, Utah 84106

The conference planning committee:
John Bockris, Texas A&M; Martin Fleischmann, U/U; Robert Huggins, Stanford; B. Stanley Pons, U/U; Hugo Ross, U/U; and Milton Wadsworth, U/U.

CONFERENCE AND CALL FOR PAPERS

WORLD HYDROGEN ENERGY CONFERENCE #8

Abstracts must be submitted by February 28, 1990.
Send abstracts (250 word limit) to:

Program Chairman, WHEC8
Hawaii Natural Energy Institute
University of Hawaii at Manoa
2540 Dole Street, Holmes 246
Honolulu, Hawaii 96822 USA

Conference is sponsored by International Association for Hydrogen Energy, U.S. Department of Energy, the University of Hawaii, and others. Sessions on Cold Fusion are scheduled to cover Experiments, Physics of Cold Fusion Reaction, and Calorimetry - Spectroscopy.

Conference will be at Honolulu at Waikiki on Oahu for the July 23 through 25. The July 26 session will be at Wailoloa on the

Big Island. Conference costs are $395 to $595 depending on where you stay and when you register.

For further information:
Telephone: (808) 948-8890
FAX: (808) 948-8890
Telex: 65027 82483 MCI

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G. FUSION PRODUCTS

VANADIUM-ZIRCONIUM BUTTONS

V_2Zr buttons can be obtained from Dr. Samuel P. Faile, P. O. Box 62579, Cincinnati, Ohio 45262, or write to Fusion Facts. These buttons can be used for Cold-Fusion Cathode Testing.

A supplier has been found who can produce buttons with a volume of about one cubic centimeter. These buttons will be made by arc melting if a laboratory shows interest in seeing if the vanadium-zirconium material would work in the cold fusion process. The buttons may have to be annealed to obtain a higher percentage of the desired compound. The interested laboratory, or course, would be free to make other modifications such as ones involving casting and machining. A lab will receive the buttons free if they are willing to inform Dr. Faile of the results of experiments in cold fusion. This alloy may be promising since N. Mitsuishi reports it can absorb hydrogen isotopes up to a composition of $V_2ZrH_{2.9}$. Also the alloy is stable and does not pulverize during repeated absorptions and de-absorptions. For those who do not want to report the results on a study using the V_2Zr buttons, two buttons can be purchased for $500.

NEW CLEAN SOURCE OF ENERGY FROM SOLID-STATE FUSION?

This scientific mystery involves many considerations. For example, can a much improved energy output from an electrochemical cell be provided by using a single-crystal rod? Would the results be improved if a change is made in the alignment of the crystallographic symmetry elements with respect to the axis of the rod? These and other interesting information on cold fusion are provided in Faile's "Annotated References on Cold Fusion and Other Related Scientific Topics".

The bibliography on cold fusion contains a chronological list of over 550 items including all aspects of the cold-fusion controversy. The document contains information from newspaper accounts and technical papers along with short essays and research tips in the form of a 55,000 word publication. This publication covers events from March 23, 1989 University of Utah claims and involvement of power companies to more recent news of major cold-fusion engineering projects in India and Japan. Examples of related scientific topics of interest includes the research of Klyuev of the USSR involving the mechanical fracture of lithium deuteride solids to electrostatically force the collision of fragments resulting in the emission of neutrons. Other topics involve various mechanisms of photon frequency multiplication and the photodisintegration of deuterium. Speculations on various new types of reactions include the formation of tritium and condensation-fission effects (six deuterium nuclei form a carbon nucleus which splits into two lithium nuclei).

The price of the publication is $500 and can be obtained directly from Dr. S. P. Faile, P. O. Box 62579, Cincinnati, Ohio 45262.

[Background on the author includes a B.S. and M.S. in Chemical Engineering, and a PhD in Solid State Science. Faile has past employment at Tem Pres/Carborundum, Pennsylvania State University, University of Dayton, Purdue University, and General Electric Company.]

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