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FUSION facts

A Monthly Newsletter Providing Factual Reports On Cold Fusion Developments

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CONTENTS FOR SEPTEMBER 1990

[The following editorial preceded the Fleischmann-Pons article in the *Journal of Electroanalytical Chemistry.* FF Ed.]

JOURNAL EDITORIAL

The preliminary note by Fleischmann and Pons published in this Journal in April of last year (261 [1969] 301), has probably generated more controversy, and even hysteria, than any other paper we have published. This work and the nature of its presentation to the public has been criticized widely on both scientific and ethical grounds. We have done our best to treat this matter according to our usual principles for the publication of new science, despite its exceptional possible implications for basic theory as well as for practical matters.

In the year since the publication of this note we have accepted a number of papers on this subject, most of which have concluded that there is no evidence for cold fusion. Rather more have been rejected on the grounds of inappropriateness to this journal or of inadequate support for their claims. These have included papers which endorse the observations of Fleischmann and Pons. None of the papers submitted has been as detailed as the follow-up paper by the original authors which appears in this issue. They have now produced a detailed description and analysis of their calorimetric experiments which support the work described in their preliminary note. We consider that this publication will go some way to bring the discussion of this problem back to a proper scientific level. It will allow those who want to reproduce these results to have a sufficiently detailed account of the design and operation of these experiments that they may expect a reasonable chance of success. On the other hand, it will allow the skeptics an opportunity to analyze the procedures in detail and to point out any apparent flaw.

We hope that with the publication of this paper the discussion of cold fusion will enter a more rational phase.....Roger Parsons

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A. FLEISCHMANN-PONS PAPER

SEMINAL PAPER ON COLD FUSION

Martin Fleischmann, Stanley Pons, Mark W. Anderson, Lian Jun Li and Marvin Hawkins (Dept. of Chemistry, U of Utah), "Calorimetry of the Palladium-Deuterium-Heavy Water System", *Journal of Electroanalytical Chemistry*, Vol 287, 1990, pp 293-348, 29 ref.

ABSTRACT

It is shown that accurate values of the rates of enthalpy generation in the electrolysis of light and heavy water can be obtained from measurements in simple, single compartment Dewar-type calorimeter cells. This precise evaluation of the rate of enthalpy generation relies on the non-linear regression fitting of the "black-box" model of the calorimeter to an extensive set of temperature time measurements. The method of data analysis gives a systematic underestimate of the enthalpy output and, in consequence, a slightly negative excess rate of enthalpy generation for an extensive set of blank experiments using both light and heavy water. By contrast, the electrolysis of heavy water at palladium electrodes shows a positive excess rate of enthalpy generation; this rate increases markedly with current density, reaching values of approximately 100 W cm^{-3} at approximately 1 A cm^{-2}. It is also shown that prolonged polarization of palladium cathodes in heavy water leads to bursts in the rate of enthalpy generation; the thermal output of the cells exceeds the enthalpy input (or the total energy input) to the cells by factors in excess of 40 during these bursts. The total specific energy output during the bursts as well as the total specific energy output of fully charged electrodes subjected to prolonged polarization (5-50 MJ cm^{-3}) is 10^2 - 10^3 times larger than the enthalpy of reaction of chemical processes.

SUMMARY

It is not possible to decide at this time whether the production of the baseline excess enthalpy and that of the bursts in enthalpy are related processes, and if so, how these phenomena might be linked. Furthermore, it is not clear whether the production of tritium is linked in any causal way to the production of enthalpy although tritium levels in the electrolyte certainly increase markedly following the bursts in enthalpy (increases of up to eight times background have been observed). It may well be, therefore, that we need to consider three separate processes (or six if both bulk and surface reactions are involved).

The contents of this report have been restricted to the calorimetric results and other data will be discussed elsewhere [to be published]. Nevertheless we close this paper with some further comments and speculations. The preliminary note was to have been published under the title "Electrochemically Induced Fusion of Deuterium?" but the all important question mark was omitted. It is our view that there can be little doubt that one must invoke nuclear processes to account for the magnitudes of the enthalpy releases, although the nature of these processes is an open question at this stage *. It should be apparent to unbiased readers that, contrary to what has been stated frequently, we did not in fact make any specific suggestions on this score in our first publication. Certainly, we suggest that these processes must be due to highly compressed deuterons and that these might be located at multiply occupied octahedral sites in the lattice. Palladium has a relatively low cohesive strength so that these sites will distort to allow such multiple occupancy at high deuteron activities although such sites might then be more accurately described as being part of dislocation loops. Grain boundaries and larger scale voids are further possible special sites. It should be noted that electrodes used under the conditions employed here become highly dislocated. Clusters of deuterons would be in effect nuclei of metallic deuterium and the boson character of the particles would play a special role in determining the outcome of collisions in these clusters. That the boson character of the deuterons is important in motion throughout the lattice is shown clearly by comparisons of the diffusion coefficients of H, D, and T in palladium. Parts of the clusters could function as spectators in any nuclear reactions although other types of negatively charged and especially neutral spectators could also be involved.**

We note finally that the deuterons in the lattice are similar to low ion temperature plasmas (~ 1 eV) and that fusion of low energy deuterons was already observed in $(ND_4)_2SO_4$ targets at the time of the discovery of the major nuclear reaction paths of deuterium (called diplogen at that time). It appears that this fact has been forgotten by the scientific community as has been the evident induction of fusion in high density, low ion temperature quiescent deuterium gas plasmas generated and maintained in magnetic mirror devices by means of electron cyclotron resonance. Deuterons in the Pd host lattice clearly can be regarded as an example of very high density low ion temperature plasmas; the fate of the nuclear reaction(s) in this case is evidently markedly modified by the presence of the host lattice.

* It is hardly tenable that the substantial number of confirmations of the calorimetric data using a variety of techniques can be explained by a collection of different systematic errors nor that tritium generation can be accounted for by any but nuclear processes.

** At a recent meeting on Solid State Fusion, Edward Teller proposed that a neutral Schlepton takes part in such nuclear processes.

Our own discussions on this point led us to name such a particle as Meschuggenon, a name more in keeping with the nature of this field of research.

EDITOR'S COMMENTS

Fleischmann and Pons were severely criticized for not providing sufficient information so that other experimenters could replicate the F-P Effect. In addition, they were condemned in the media as having inadequate skills to make proper calorimetric measurements. In one case, a fellow scientist first announced to the media that they were making errors in their calorimetry, then after discussion with Fleischmann and Pons rendered a verbal apology on the floor of the conference. Unfortunately, the apology received no media coverage.

This, then, is the seminal paper (submitted in December 1989 with some revisions in March 1990), which is now published for the review and critique of fellow scientists. This paper replaces the preliminary note submitted in March 1989. The paper deserves the serious review of fellow scientists.

During the past few months, some of us have speculated on the warning in the preliminary paper {*J.Electrochem.* 261 (1989) 301} in the experiment using a one cm cube of Pd. The table states, "WARNING! IGNITION! See Text". The text states, "We have to report here that under the conditions of the last experiment, even using D_2O alone, a substantial portion of the cathode fused (melting point 1554 C), part of it vaporized, and the cell and contents and a part of the fume cupboard housing the equipment were destroyed."

In this current paper the following comments are worthy of note: "It is also not possible to decide at this stage whether the attainment of boiling [of the electrolyte] is due to a burst in enthalpy production or to an increase in the baseline output since we have adopted a policy of discontinuing the experiments (or, at least, of reducing the current density) when the boiling point is reached. The reasons for this are as follows: the dissolution of D in Pd is exothermic under these conditions: rapid increases of temperature must therefore be accompanied by a marked increase in the chemical potential (fugacity) of dissolved D^+ since chemical equilibrium cannot be established by the relatively slow diffusional relaxation processes. **We reiterate the warning which we gave in the preliminary publication: such conditions should be avoided at the present stage of research since they could lead to uncontrollable energy releases.** We also draw attention to the fact that rapid increases of temperature are accompanied by marked increases in the rate of generation of tritium."

The recent model of cold fusion by Dr. Robert T. Bush (accepted for publication in *Fusion Technology* probably January 1991) may provide for an improved understanding of this type of run-away phenomenon. Bush's model predicts enhanced fusion rates that are strongly temperature dependent (at specific temperatures). Therefore, a cell approaching such a temperature from one direction could increase markedly and from a higher temperature (decreasing) would seem to be self-limiting.

There have been a large number of experiments, and many successful replications have been achieved since the March 23, 1989 announcement and the appearance of the preliminary note by Fleischmann and Pons. *Fusion Facts* has reported on over 300 papers in its first year of publication.

Most of these papers reported positive findings. As of this date of receipt of the Fleischmann-Pons et al. paper, we are impressed by two contrary events:

1. The fact that all three findings that were originally reported (excess heat, neutrons, and tritium) have all been verified in a deuterium-Pd or a deuterium-lithium-Pd system by many scientists.

2. The intense denial of cold fusion and the personal attacks on Fleischmann, Pons, and some other workers (e.g. Kevin Wolf at TAM) that have ensued.

We look forward to the next developments in this interesting and important new science. With our forecaster's hat, we predict that scientists in all parts of the world will accept and expand on the Fleischmann-Pons Effect and that commercial applications will be found within the next three years. We share the same hope as Roger Parsons, Editor of the *Journal of Electrochemistry*, that, "with the publication of this paper the discussion of cold fusion will enter a more rational phase". [FF Ed.]

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B. PRINTED ARTICLES ON COLD FUSION SUMMARY

By Hal Fox

This past month has brought a plethora of printed papers on cold fusion. Specifically, the following two are important collections:

The First Annual Conference of Cold Fusion, Conference Proceedings, March 28-31, 1990, University Park Hotel, Salt Lake City, Utah, Sponsored by the National Cold Fusion Institute. Available from Director, NCFI, 390 Wakara Way, Salt Lake City, Utah 84108. Price $55

Fusion Technology, A Journal of the American Nuclear Society. The August 1990 issue (Volume 18, Number 1) is completely devoted to cold fusion articles. Published by The American Nuclear Society, Inc., 555 No. Kensington Ave., La Grange Park, Illinois 60525, telephone 708/352-6611. Subscription rate is $250 per calendar year (2 volumes). Single issues $39. Published monthly except August (usually) and December. Overseas subscribers add $25 per year for postage and handling. [Note: See section C of this issue for a listing and summary of the articles in this special August issue of Fusion Technology.]

See the notices at the end of this issue for information about the Proceedings of the Cold Fusion Symposium recently held as a part of the World Hydrogen Conference #8 in Hawaii (July 23-24, 1990).

Another excellent compilation of papers is:

P.K. Iyengar and M. Srinivasan, editors, *BARC Studies in Cold Fusion* (April - September 1989), Bhabha Atomic Research Centre, Trombay, India, 1 Dec 1989. [A collection of 20 papers showing positive results in the scientific replication of the Fleischmann/Pons work. Published by the Government of India, Atomic Energy Commission, BARC, as BARC-1500.] Note: These same papers are reprinted in the article by P.K. Iyengar et al. (50 authors), "Bhabha Atomic Research Centre Studies in Cold Fusion", *Fusion Technology*, Vol 18, No 1, August 1990, pages 32-94. [See section C.]

Two important conferences for which proceedings are still to be published are:

1. Workshop on Cold Fusion Phenomena, May 23-25, 1989, Santa Fe, New Mexico. Sponsored by Los Alamos National Laboratory and the U.S. Department of Energy. An abbreviated version of the proceedings has been published and is available through NTIS, U.S. Dept. of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

2. The National Science Foundation and Electric Power Research Institute sponsored the Workshop on Anomalous Effects in Deuterated Materials, Washington, D.C., October 16-18, 1989. Some of the papers have been published elsewhere. See *Fusion Facts*, Vol 1 No 5, November 1989, page 8ff.

This NSF/EPRI workshop is important for two reasons: First, some of those invited had achieved negative results but by the time of the conference they had achieved positive results. Therefore out of about 32 papers, 30 were positive.

The second reason is that this important private conference was attended by several members of the Department of Energy Cold Fusion Panel who heard the positive results given on the production of tritium. However, in the Panel's report they choose to essentially ignore some of the more important research results. For example, they made the following statement concerning tritium: "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." [emphasis added]

The inconsistency cited by the panel is the strong belief that neutrons and tritium should be produced in equal amounts as observed in a high-energy deuterium experiment. Experiments before this meeting and since have established the scientific fact that tritium and neutrons are not produced in equal amounts in a cold fusion environment. Therefore, the panel denied cold fusion based on previous hot fusion results, which are shown to be markedly different than cold fusion. The effective result has been a slowdown in fusion research in America (but not in Japan nor India).

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C. AUGUST ISSUE OF FUSION TECHNOLOGY

This special issue of Fusion Technology, as the editor, George Miley explains, "is unique in that the contributed papers are all devoted to cold fusion. ... the momentum [submitted papers] in this area has been gradually growing, and recently we found ourselves with a large backlog of accepted contributions." Prof. Miley and the American Nuclear Society are to be congratulated for adapting their journal to handle a special section on cold fusion (during the past year) and especially for this Vol 18 No 1, August 1990 special issue devoted to cold fusion papers.

Miley also makes the following important observation, "...the field [of cold fusion] has not yet matured to the point where theory and experiment can be directly compared. The problem is that diagnostic techniques have not yet conclusively identified the nuclear reaction products and at the same time there has not been a consensus about the appropriate theory. Thus the mystery of cold fusion remains. Still, as seen from these and earlier technical notes, rapid progress is being made, so we can anticipate a rapid maturing of the field."

REVIEW OF PAPERS

BOCKRIS - TEXAS A&M

John O'M Bockris, Guand H. Lin, and Nigel J.C. Packham (Texas A&M), "A Review of the Investigations of the Fleischmann-Pons Phenomena", *Fusion Technology*, Vol 18, No 1, August 1990, pp 11-31, 61 refs.

ABSTRACT

A review of the recent investigations of the Fleischmann-Pons effect ("cold fusion") is given. A discussion of the proposed theories and models to account for the observations is also given. Suggestions for future research in this area are discussed.

EDITOR'S COMMENTS

Prof. Bockris and other scientists at Texas A&M were among the first scientists in the U.S. to replicate the Fleischmann-Pons Effect. In addition, Dr. Bockris is one of world's most noted electrochemists. This paper is recommended reading, especially for those who are new in this exciting field or for those who have previously dismissed cold fusion as "pathological science". [FF Ed.]

IYENGAR - BARC IN INDIA

P.K. Iyengar, M. Srinivasan, S.K. Sikka, A. Shyam, V. Chitra, L.V. Kulkarni, R.K. Rout, M.S. Krishnan, S.K. Malhotra, D.G. Gaonkar, H.K. Sadhukhan, V.B. Nagvenkar, M.G. Nayar, S.K. Mitra, P. Raghunathan, S.B. Degwekar, T.P. Radhakrishnan, R. Sundaresan, J. Arunachalam. V.S. Raju, R. Kalyanaraman, S. Gangadharan, G. Venkateswaran, P.N. Moorthy, K.S. Venkateswarlu, B. Yuvaraju, K. Kishore, S.N. Guha, M.S. Panajkar, K.A. Rao, P. Raj, P. Suryanarayana, A. Sathyamoorthy, T. Datta, H.G. Bose, L.H. Prabhu, S. Sankaranarayanan, R.S. Shetiya, N. Veeraraghavan, T.S. Murthy, B.K. Sen, P.V. Joshi, K.G.B. Sharma, T.B. Joseph, T.S. Iyengar, V.K. Shrikhande, K.C. Mittal, S.C. Misra, M. Lal, and P.S. Rao (BARC, Trombay, Bombay, India), "Bhabha Atomic Research Centre Studies in Cold Fusion", *Fusion Technology*, Vol 18, No 1, August 1990, pp 32-94, 16 papers, many references.

FUSION TECHNOLOGY COMMENTS

This collection of technical notes on cold fusion was submitted by staff from the Bhabha Atomic Research Centre (BARC) in India. They have gone through the technical note review process and appear here as a collection of reports that provide insight into the breadth of the studies at BARC. The preface is an edited version of the inaugural talk delivered by P.K. Iyengar, Director at BARC, at the meeting on cold fusion held in Trombay on May 18, 1989. George Miley, ed.

EDITOR'S COMMENTS

The preface and the collection of 11 papers on experimental work with electrolytic cells plus 5 papers on gas-loading experiments report on the April through September 1989 work performed at BARC. These papers are of both scientific and historic interest. It should be recalled that within less than a month after the Fleischmann-Pons announcement of the discovery of cold fusion, ten teams of scientists in India had replicated one or all of the effects reported by Fleischmann and Pons.

These papers were previously published by the Atomic Energy Commission of India as BARC paper 1500, Dec 1, 1989. A copy of this publication was obtained (courtesy of Dr. Guruswamy) and reviewed in the February 1990 issue of *Fusion Facts*. Several of the investigators were among the first to emphasize the experimental and unexpected findings that the expected 1:1 branching ratio of tritium to neutrons was not being observed in cold fusion experiments. [FF Ed.]

10^8 NEUTRONS IN JAPAN

Yoshiaka Arata (Kinki U.) and Yue-Chang Zhang (Osaka U), "Achievement of an Intense Cold Fusion Reaction", *Fusion Technology*, Vol 18, No 1, August 1990, pp 95-102, 8 ref.

ABSTRACT

Intense neutron generation at a rate of > 10^8 n/s in cold fusion was achieved when neutron emission "avalanches" were observed as deuterium forcefully penetrated into a large 2-cm-diam x 5-cm-long palladium cathode. A very specific process involving intense charging and discharging of deuterium from the palladium cathode during continuous electrolysis of heavy water, called the "on-off" effect, was discovered. The effect is 10 to 100 times stronger than the ordinary on-off effect of the current. As the palladium absorbed and exhausted the deuterium, the thermal behavior of the palladium was examined in detail. It is concluded that the particular characteristics of palladium and the generation of a huge inner pressure within the palladium are necessary conditions for a cold fusion reaction.

Other researchers have used a much smaller palladium cathode than the one used here. They measured only the electrolysis temperature, and not the cathode temperature. Thus, their experiments failed to discover the thermal

characteristics of the palladium cathode, the on-off effect, and intense cold fusion. This experiment proves that an unknown nuclear fusion process that generates a large amount of heat, as proposed by others, does not exist. Instead, the heat is actually reaction heat generated by the explosive absorption and exhaustion of the deuterium in the palladium cathode, caused by the "on-off" effect.

EDITOR'S COMMENTS

The authors note the following, "The maximum number of neutrons detected during theses experiments was about 10^{13} per event. At this point, it is difficult to assume any reaction other than deuterium nuclear fusion."

The authors also emphasize, "If a small cathode is used, the temperature [of the cathode] cannot be measured correctly and the cathode cannot rise beyond the boiling point of the electrolyte. Furthermore, some researchers have used an extremely small cathode such as foil, with a thickness less than a few millimeters. Such a small cathode will quickly be formed over by stable palladium deuteride. The tremendous internal pressure needed for cold fusion also cannot be generated, nor can the intensive free movement of deuterium be obtained. Therefore, cold fusion will not occur no matter how long the electrolysis is continued. Hence, using a small cathode in cold fusion research is a fatal mistake. Unfortunately, most researchers have not been aware of the importance of this issue. In our experiments, we used a cathode with a 2-cm diameter and a 5-cm length."

In discussing long-term electrolysis, the authors state, "...we believe that performing electrolysis for too long a time is not effective. We think that the minimum requirement for generating an intense cold fusion reaction is to activate the palladium surface and send deuterium into the palladium as rapidly as possible. Long-term electrolysis makes the surface inactive and, in some cases, prevents deuterium from absorbing. The surface [of the cathode] must be polished periodically. Also, the deuterium density in the palladium must be as high as possible, and extremely high pressure and intense mobility (high speed and free movement) [of the deuterons] must be present." It should be noted that previous experimenters found better results (using small Pd wires) when "loading" was done slowly. It has been suggested that slow loading allows the Pd to expand with minimal fractures. [FF Ed.]

OAK RIDGE AND GAMMA RAYS

Charles D. Scott, John E. Mrochek, Timothy C. Scott, Gordon E. Michaels, Eugene Newman, and Milica Petek (Oak Ridge Chem. Technology Div.), "Measurement of Excess Heat and Apparent Coincident Increases in the Neutron and Gamma-Ray Count Rates During the Electrolysis of Heavy Water", *Fusion Technology*, Vol 18, No 1, August 1990, pp 104-114, 11 refs.

ABSTRACT

Excess heat and apparent increases in the neutron and gamma-ray count rates have been observed in a series of tests performed at Oak Ridge National Laboratory to study the electrolysis of heavy water in the presence of palladium cathodes. For these tests, LiOD at a concentration of 0.1 to 1.0 N in D_2O was used in an insulated glass electrochemical cell in which the temperature was controlled and heat removed by flowing water in a cooling jacket. Results of two of the tests, one of which lasted for over 1900 h, are reported. In the latter test, an internal D_2-O_2 recombiner was incorporated into the cell to give a closed-system without off-gas.

Excess power, usually in the range of 5 to 10%, was detected for periods of many hours. Some of these events were initiated and could be extended by system perturbations. On three separate occasions, the mean neutron count rate exceeded the background by statistically significant values; one of these was apparently coincident with an extended period of excess heat generation. Increases in the gamma-ray count rates were apparently also coincident with two of the periods of excess neutrons.

DISCUSSION

The several periods of excess power were unequivocal and could not be explained by experimental inaccuracies or artifacts. Apparent increases in the neutron and gamma-ray count rates were quite modest and perhaps could be explained by some sort of unknown variations in the background levels of the two separate monitoring systems. However, the apparent coincidence of increases in two independent detectors, and especially the coincidence with an extended period of induced excess power and the concurrent decreases when light water was added to the electrolysis system, gives more credence to the results.

The replacement of LiOD-D_2O with LiOH-H_2O resulted in an ultimate reduction of excess power and a decrease of the neutron and gamma-ray count rates to background values. These observations suggest that deuterium is a necessary component of the electrolyte for positive results; however, the length of time required for the reductions was well over 100 h. This finding could be interpreted as demonstrating that the possible interactions are bulk phenomena, which occur throughout the cathode matrix, rather than surface phenomena, which would have

disappeared very rapidly after removal of the source of deuterium.

EDITOR'S COMMENTS

This cold fusion research is especially important because it has been accomplished by one of the DoE-funded national laboratories and, in addition, the experiments have been carried out over long periods of time. In addition, the Pd cathode is somewhat larger than with many other experiments (0.55 cm diam x 8 cm). The exchange of heavy water with light water has been done by other experimenters with conflicting results. However, the size of the Pd cathode used in this experiment caused some excess heat to continue for over 100 hours. Thus, it appears that the reactions were bulk reactions. Another interesting result was the demonstration that reactions could be induced by introducing system perturbations. [FF Ed.]

ITALY AND GAS-LOADED PALLADIUM

Sebastiano Aiello, Enrico De Filippo, Gaetano Lanzano, Salvatore Lo Nigro, and Angelo Pagano (Istituto Nazionale di Fisica Nucleare and Dept of Physics, U. of Catania, Italy), "Nuclear Fusion Experiment in Palladium Charged by Deuterium Gas", *Fusion Technology*, Vol 18, No 1, August 1990, pp 115-119, 12 refs.

ABSTRACT

A palladium-deuterium system subject to different experimental thermodynamic conditions was studied to look for low-temperature d-d fusion reactions. Neutrons, light charged particles, and energetic gamma rays were detected. No significant effects were observed in the neutron and gamma-ray measurements. From the analysis of the light charged particles, a fusion rate of about 10^{-23} events per deuteron pair per second was deduced.

CONCLUSION

In conclusion, the obtained fusion rate per deuterium pair is in good agreement with the upper limit values reported by Rehm et al and by Brushi et al., but it is four orders of magnitude smaller than that deduced from DeNinno et al. Our experimental apparatus is insensitive to the low values of fusion rates suggested by M. Gai. [Note: article cites references.] The results presented stress the importance of performing measurements by improving both the light charged-particle identification system and the sensitivity of the neutron detection with respect to the background in order to obtain more definitive conclusions on the existence of the investigated processes.

EDITOR'S COMMENTS

Although the experiments showed marginal results in the detection of neutrons there were modest indications of gammas that were consistent with the d + d --> ^{3}H + p (3-MeV protons). These investigators are encouraged to try some of the more promising gas-loading experiments such as the ones described by Claytor or the neutron-producing Pd wafer experiments performed by Yamaguchi and Nishioka at the Japanese NTT labs. We commend all of these researchers on their careful experimental work that is teaching all of us more about cold fusion.

GERMANY - METHODOLOGY FOR DETECTION

M. Bittner, A. Meister, D. Ohms, E. Paffrath, D. Rahner, R. Schwierz, D. Seeliger, K. Wiesener, and P. Wustner (Dresden U. of Tech), "Method for Investigation of Fusion Reactions in Condensed Matter", *Fusion Technology*, Vol 18, No 1, August 1990, pp 120-130, 13 refs.

ABSTRACT

A method for studying deuterium-deuterium fusion neutron production in condensed matter together with experimental results are presented. The method is based on long-term measurements for comparison among different cells with electrolytically charged palladium cylinders and background. The statistical method used for data reduction is presented, which enables identification of even very small effects. In the experiment, for about 100 hours, an excess counting rate of about 3 counts per hour (averaged for this period) above the background level was found.

CONCLUSIONS

The aim of this work is to present and discuss a method developed to investigate the possible production of D-D fusion neutrons during the loading of suitable metals with deuterons at very low levels of reaction rate. The method of investigation presented also allows one to estimate the influence of cosmic radiation either as a source of secondary fast neutrons or through muon-catalyzed fusion. Both the shadow effect in channel groups 2 and 3 and the zero counting rates in channel group 4 give upper limits on the cosmic-ray-induced neutron production in the cells, whereas the long-term measurement with samples under special conditions allows to set limits on the cosmic ray muon-catalyzed fusion both in the palladium-deuterium sample and the electrolyte. In one sample, the occurrence of a small neutron counting excess on the order of 3 counts per hour averaged over a 100-hour interval is indicated which corresponds to a specific fusion rate of

3×10^{-4} per g per second in the palladium. The measurement of effects at this low level is near the limits of the experimental technique.

EDITOR'S COMMENTS

Here again, the experimenters are to be congratulated on their excellent approach which can provide significant measurements of very small events. However, with the new findings that are being made and reported, there are now improved methods that should allow new experimenters to produce cold-fusion electrochemical cells that will generate rather extensive excess energy without producing neutrons. As pointed out by Fleischmann and Pons in their expanded paper, "Although low levels of tritium and, possible, of neutrons were detected, the enthalpy release was evidently substantially aneutronic and atritonic." These researchers may find similar methods to simplify the measurements of excess heat that seems to be the most consistent measure of cold fusion events. [FF Ed.]

ITALY - ACTIVITY REPORT

A. Foglio Para, V. Sangiust, P.L. Cavallotti, U. Ducati, and P.F. Bortignon (Milano Polytech), "Neutron Monitoring and Related Measurements During Electrolysis of Heavy Water with Palladium and Titanium Cathodes: Activity Report", *Fusion Technology*, Vol 18, No 1, August 1990, pp 131-134, 10 refs.

ABSTRACT

Results obtained in more than 100 electrolysis experiments of D_2O with palladium and titanium cathodes, characterized by continuous high-efficiency neutron monitoring, are reported. In two runs with palladium cathodes, anomalous counts were observed that could not be rejected as evident spurious signals. In one of the two runs, anomalous counts were simultaneous with deformation of the palladium cathode. The two events are reported as candidates events of neutron emission. Moreover, in 2 (of 30) experiments with pulsed current, a statistically significant difference between counts in the charging and in the relaxation phases was observed. Some tritium measurements in the electrolyte solution were carried out, with no evidence of tritium contamination over the natural content. Analyses of the gases from the cathodes revealed the presence of species with masses of five and six, which could be attributed to DDH and D_3 molecules.

CONCLUSIONS

The anomalous counts registered during our 3-month activity and assumed as candidate events of deuterium-deuterium fusion reactions were always obtained in highly nonequilibrium conditions. Therefore, the corresponding fusion rates cannot easily be compared with those obtained by other groups and with the much smaller (at least 20 orders of magnitude) upper limit of fusion rates calculated by the equilibrium theory of Leggett and Baym.

U. OF ARIZONA - CATALYSIS THEORY

Johann Rafelski, Mikolaj Sawicki, Mariusz Gajda, and David Harley (U. of Ariz), "How Cold Fusion Can Be Catalyzed", *Fusion Technology*, Vol 18, No 1, August 1990, pp 136-142, 27 refs.

ABSTRACT

A yet undiscovered ultra-heavy, negatively charged particle X^-, a remnant from the early Universe, could be the origin of diverse cold fusion phenomena. The possibility that the random fusion neutrons reported by Jones et al. in association with electrolysis of heavy water may be caused by inflight X^- induced reactions is considered in detail. The catalysis of other cold fusion phenomena such as heat production without penetrating radiation, or tritium production without production of neutrons, is also discussed.

SUMMARY

We have demonstrated that the presence of heavy negatively charged particles can best be recognized by observing their nuclear catalytic activity. With our limited knowledge of both the flux and possible terrestrial abundance of X^-, it is very difficult to make a definitive statement about the most critical experiment. In particular, we have not understood how the (electrolytic) process of hydrogen loading into the metallic lattice impacts the fusion rate. This issue is subject to understanding the interaction of Xd with matter. Interestingly, if X^- catalyzed fusion is behind some of the diverse phenomena, we should expect it to occur spontaneously without need for electrolysis, provided that we are able to create an environment suitable for the processes. Obviously, only more detailed theoretical knowledge of the Xd/matter interaction will permit us to detail such experiments.

EDITOR'S COMMENTS

Fortunately, some of the questions being asked by the authors, especially with regard to the role of electrolysis, are being reasonably addressed by some of our better theoreticians, e.g. Bush, Hagelstein, Yeong Kim, and others whose work we have the privilege of reviewing frequently. See the next two articles in this same publication for more theory. Also see the last article of section G in this issue of *Fusion Facts* by Bush.

ITALY -DYNAMICAL MODEL

Eugenio Tabet (Inst. Superiore di Sanita), and Alexander Tenenbaum (U. La Sapienza), "A Dynamical Model for Cold Fusion in Deuterated Palladium", *Fusion Technology*, Vol 18, No 1, August 1990, pp 143-146, 11 refs.

ABSTRACT

A dynamical model is proposed to account for cold fusion processes in deuterated palladium on the basis of lattice collapse induced by thermodynamic instability. The relevant role of deuteron drag in enhancing the nuclear fusion rate is analyzed. The nuclear reaction yield is explicitly calculated as a function of the palladium-deuterium thermodynamic parameters.

SUMMARY

Nevertheless, we have shown that a process based on lattice collapse and deuteron drag can, under favorable conditions, produce a significant amount of fusions in a metal, of the order of magnitude found in some of the above-mentioned experiments. Moreover, an enhancement should be expected if the core region were supersaturated with dragged deuterons; this would happen, for high values of alpha and beta, if thermal fusion of the lattice occurred at the center of the collapsing region. This would also extend the activation time of the deuterons to values typical for the thermal diffusion of the energy from the melted region. Finally, we also note that the pronounced dependence of the nuclear reaction yield on the nominal concentration could be a clue to understand the difficulties met in repeating the experiments.

EDITOR'S COMMENTS

If my understanding is correct, this theory would not explain the electrolytic cells that produce continual excess energy over periods of months (such as Huggins et al, at Stanford). [FF Ed.]

PURDUE - VELOCITY DISTRIBUTION

Robert A. Rice, Gary S. Chulick, Yeong E. Kim, and Jin-Hee Yoon (Purdue Univ.), "The Role of Velocity Distribution in Cold Deuterium-Deuterium Fusion", *Fusion Technology*, Vol 18, No 1, August 1990, pp 147-150, 13 refs.

ABSTRACT

Reaction rates from recent electrochemical fusion experiments have been found to be as many as seventy orders of magnitude larger than those obtained from simple calculation involving an extrapolated low-energy deuterium-deuterium (D-D) cross section and a sharp velocity distribution. However, if an appropriate Maxwell-Boltzmann velocity distribution is used in place of the conventional sharp (mono-energetic) velocity distribution, the calculated reaction rate increases by as much as fifty to sixty orders of magnitude. Furthermore, the center-of-mass energy at which the D-D cross section is evaluated for given D-D energy is much larger than that used in the conventional calculations due to the higher energy components in the Maxwell-Boltzmann distribution. Finally, the above results are not significantly affected if a reasonable high-energy cutoff E_c is included in the velocity distribution.

SUMMARY

It is shown that the low-energy D-D fusion rates, lambda, calculated with a Maxwell-Boltzmann deuteron velocity distribution are astronomically larger (a factor of 10^{52} at E_{D-D} about 30 eV) than the conventional estimates for lambda calculated with a sharp velocity distribution. The claimed values for lambda (10^{-19} per sec for tritium production and 10^{-23} per sec for neutron production) are consistent with the surface reaction mechanism when the deuteron flux with a Maxwell-Boltzmann velocity distribution is maintained at average kinetic energies of 20 eV and 15 eV, respectively; these energies correspond to an applied potential of 40 and 30 V, respectively, for electrolysis experiments. For the claimed values by Fleischmann et al., and Appleby et al. for excess heat (about 10^{-10} per sec) an additional increase of about 10^{10} in the value of D-D fusion cross-section is needed at energies of about 20 eV.

EDITOR'S COMMENTS

The reader should also see a later paper by Dr. Yeong Kim presented at the World Hydrogen Energy Conference #8 in Hawaii, July 24, 1990. This paper is reviewed on page 12 of the August issue of *Fusion Facts*. This later paper is the result of some additional months of work by Dr. Kim et al. as compared to the February 1990

submission date for the above article in *Fusion Technology*. This disparity in current achievements, both in theory and experiments, as compared to the material that is currently being published is the most compelling reason for sharing information through publications (such as *Fusion Facts*) that can process and publish information within 30 days after it is received. [FF Ed.]

SUMMARY OF THIS SPECIAL AUGUST 1990 ISSUE OF FUSION TECHNOLOGY

We are greatly indebted to the American Nuclear Society and to the editor of *Fusion Technology*, Prof. George Miley, for the splendid work they are doing to help distribute peer-reviewed articles on the many aspects of cold fusion. *Fusion Technology* is one of the few journals that has been providing a special section on Cold Fusion. Each issue for about the past year has had three or more cold fusion articles. We highly recommend that you ensure that your library is receiving this important journal.

We should all be grateful that the American Nuclear Society did not adopt an anti-cold fusion bias such as adopted by *Nature*. Playing politics with science (as seemingly done by the now disbanded DoE Cold Fusion Panel) and attempting to discredit new findings by innuendo and ridicule (leaders of American Physical Society and *Nature*) is not consistent with the meaning of "science" or "scientist". [FF Ed.]

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D. OTHER NEWS FROM U.S.

14TH ANNUAL UTAH CONFERENCE ON ENERGY, MINING AND NEW TECHNOLOGY

INTERNATIONAL PERSPECTIVES ON FUSION ENERGY

This session was chaired by Dr. James J. Brophy, V.P. for Research of the Univ. of Utah. Dr. Brophy was closely associated with the founding of the National Cold Fusion Institute (U/U Research Park).

Dr. Brophy observed that after 18 months of controversy, cold fusion had been verified by over 60 groups in various parts of the world. However, Brophy pointed out, the reality of cold fusion is still not generally accepted.

The Panel members gave presentations as follows:

JANDEL - THEORY

Dr. Magnus Jandel is a physicist from Manne Stegbahn Institute of Physics in Stockholm, Sweden.
Jandel reported that a considerable amount of work was done in Sweden by two groups. One group recorded one burst of neutrons but were unable to repeat the event. Another group achieved excess heat with their first experiments but later results were ambiguous.

Dr. Jandel has been working on a theory for cold fusion that involves strongly-coupled plasmas. Further work could be expected to be funded in Sweden provided that there is further evidence and/or directions to ensure successful experiments.

PREPARATA - THEORY

Dr. Giuliano Preparata is a professor of theoretical physics at the University of Milan. Dr. Preparata has published more than 250 papers in high-energy physics, laser physics, molecular biology, and condensed matter physics. Dr. Preparata presented an excellent theory paper at the March 1990 First Annual Cold Fusion Conference.

Dr. Preparata stated that he was optimistic based on reason. He suggested that there were two groups who were pessimistic about cold fusion: First, vested interests who have the need to control, and second, scientists who were ignorant of or who had incomplete knowledge of the inner workings of condensed matter. Dr. Preparata restricted his remarks to the second group.

After reviewing the difficulty of explaining cold fusion by classical physics, Dr. Preparata presented his work based on quantum field theory of superradiance and its application to cold fusion data. He stated that in classical condensed matter physics the long-range radiation (propagated at the speed of light) is usually neglected without any valid reason. Superradiance considers the long-range radiation and, properly reasoned, can be used to explain many of the puzzling facts of condensed matter.

Based on his theoretical work, Preparata shows that we can find natural mechanisms to explain the following:

1. Overcoming the coulomb barrier through collective oscillations of the peripheral electrons in the Pd lattice.

2. Greatly increasing the rate of fusion of d + d in the Pd environment.

Preparata closed with his judgement that cold fusion is a real phenomena that follows the laws of nature. He commended Fleischmann and Pons for their initial work

that is leading the world into a greater understanding of nuclear reactions in this cold fusion environment.

SRINIVASAN - 100 MAN YEARS OF RESEARCH

Dr. Mahadeua Srinivasan is the head of the Neutron Physics Division at the Bhabha Atomic Research Centre (BARC) near Bombay, India.

Dr. Srinivasan reported that several divisions of BARC with over 50 scientists plus support personnel have been working on cold fusion. Their work began within a few days after the March 23, 1989 public announcement of the discovery of electrochemical cold fusion. These groups have been working with electrochemical cells, gas-loading of Pd and Ti, and plasma-induced fusion.

Dr. Srinivasan closed his remarks stating that over 100 man-years of effort has now been spent in investigating cold fusion at BARC. There is no longer any question of the reality of both neutrons and tritium being produced in cold fusion structures using both palladium and titanium together with deuterium.

For further information on work being done in India refer to the review of the article by Iyengar et al. (50 authors) from the August issue of *Fusion Technology* [reviewed in section C of this issue of *Fusion Facts*].

TAKAHASHI - JAPANESE SUCCESSES

Dr. Akito Takahashi, Professor of Nuclear Engineering at the University of Osaka, Japan gave a special presentation on his work.

Dr. Takahashi has been performing experimental and theoretical work on the production of neutrons from a palladium-lithium-deuterium electrochemical cell. Special efforts were made to produce neutrons and to measure the energy of those neutrons. By measuring the energy level of the neutrons it is possible to investigate the type of nuclear reaction known to produce neutrons of that energy.

Dr. Takahashi has measured a sharp energy peak at 2.45 MeV plus a smaller broad peak in the region of 5-7 MeV. The theory that he has been developing suggests that the 2.45 MeV energy peak is associated with a two-body d + d nuclear reaction. He theorizes, subject to later experimental confirmation, that a three-body nuclear reaction may be responsible for the second energy peak.

Here are Dr. Takahashi's conclusions:

1. Cold Fusion is real and involves nuclear reactions.
2. Neutrons are produced from an electrochemical cell.
3. The energy spectra of these neutrons have been measured.
4. There may occur a 3-body nuclear fusion event(s).
5. An "excitation screening effect" could be induced by an electron potential gap at the surface of the palladium cathode.
6. The tritium to neutron production ratio is about 10^5.

WILL - SUCCESS SUMMARY

Dr. Fritz Will was the concluding presenter on the panel. Dr. Will is the Director of the National Cold Fusion Institute at the University of Utah's Research Park. Dr. Will recently returned from a trip to Japan and India where he met with fellow scientists to discuss the latest findings in cold fusion. [See *Fusion Facts* for August 1990 for Dr. Will's report].

Dr. Will reported that there have been dramatic actions here (U/U) and at other parts of the world in the continuously developing area of cold fusion. Since Drs. Pons and Fleischmann reported their dramatic discovery (March 23, 1990) many labs have replicated the effect but many labs have come up empty-handed. There are many conditions that have to be satisfied to have a successful cold fusion experiment and some of these conditions are not fully understood.

Dr. Will emphasized that cold fusion is not a phantom but is a reality although not all scientists share that view. There is a strong undercurrent from those who do not want to have cold fusion be a reality and some few have even verbally attacked fellow scientists. In India and Japan that is not a problem. Will quoted Professor Ikegami (Japan) who stated, "We in Japan are interested in proving cold fusion, whereas our colleagues in the United States seem more interested in disproving it."

Dr. Will presented a review of cold fusion results and cited the many groups that have produced one or more of the effects of cold fusion (excess heat, tritium, and neutrons). As significant new results he cited the work by Faler and Vegors at Idaho State U.; the work by Claytor et al. at Los Alamos; the work done (but not yet published) at the Naval Ordnance Labs in San Diego; and recent other improvements.

Dr. Will concluded with the following:
1. Many groups have reported successful cold fusion experiments.
2. The results cannot be attributed to artifacts or human error.
3. "On demand" cold fusion is still elusive.
4. The physics of hot fusion does not fully apply.
5. New theories are needed.
6. Promising models are emerging.

PANEL ANSWERS TO QUESTIONS

Scientists now working in cold fusion now number about 200 in Japan, over 60 in India, and about 30 in the United States.

The range of continuous excess heat being achieved ranges from 2% to over 30%, with larger events observed as bursts of heat. [The 30% figure has since been greatly exceeded by researchers such as Liaw and Liebert at Hawaii.]

Preparata stated that we are learning some new physics that have shattering conclusions. Up to now we have not really understood matter. Now we need to have bright people to find out what is happening. We need completely new ways of looking at the working of a metal lattice. Matter can do some fantastic things we didn't know about. The scientific and the political communities need to open up and support this discovery.

EDITOR'S COMMENTS

It was a most interesting experience to listen to well-informed experts from five countries tell about the work being done in cold fusion. Except for the tentative successes from Sweden, all other panelists are declaring that cold fusion is a demonstrated reality in their countries. All that is needed now is for that testimony (supported by the numerous existing peer-reviewed publications) to get to the attention of DoE, the *N.Y. Times*, and the *Wall Street Journal.* When these three entities are also convinced that cold fusion is a reality and that there are potential commercial applications, there will be an immediate strong interest in funding cold fusion developments. [FF Ed.]

TEXAS A&M - REVIEW OF COLD FUSION

J.O'M. Bockris and D. Hodko (Sfc. Electrochem. Lab, TAM), "Is There Evidence for Fusion Under Solid State Confinement", (to be submitted for publication), 27 pages, 5 figures, 76 ref.

EDITOR'S ABSTRACT

Any scientist who has tried to replicate the Fleischmann-Pons effects will sympathize with the many who have declared that the cold fusion effects do not exist. Due to the difficulties of replication, the lack of published directions to produce cold fusion effects on demand, some negative papers have been published. Conversely, over sixty laboratories in twelve countries -- including five national laboratories in the U.S. -- have reported (and/or published) experimental verification of the Fleischmann-Pons effects. This paper tabulates 79 such groups and identifies their findings under the headings HEAT, TRITIUM, NEUTRONS, GAMMA-RAYS, and HELIUM-3. Typical results are discussed in sections on HEAT, TRITIUM, NEUTRONS, GAMMA-RAYS, HELIUM, THE THEORY, and THE SOCIOLOGY.

EDITOR'S COMMENTS

This is an excellent article to summarize both the findings and the pitfalls of cold fusion. This summary report is highly recommended reading for any who doubt the reality of cold fusion phenomena. The figures provide illustrations and graphs showing the following: The Fleischmann-Pons cell; McKubre's graphic data on excess heat; Scott's neutron measurement methods; BARC simultaneous neutron measurements; and data from Scott on tritium production.

In commenting on the ludicrous sociological developments surrounding cold fusion the authors share the following: "One man, a Ph.D. from a national lab, asked me to step into a conference room at a meeting, shut the door, pulled graphs and results from his briefcase and said, 'Don't tell anyone about this. My boss would kill me if he knew I was telling you: I have positive results.'"

Bockris and Hodko ask themselves why anyone should try to do research on cold fusion. They answer, "For myself, I consider there are enough accounts around to indicate that conditions can sometimes be obtained which cause bursts of nuclear events to occur at electrodes in the cold [fusion cell]. But such occurrences are so **totally** unexpected, - denied by classical hot plasma theory, - that their seeming presence opens a door on a New Vista in Science, - wide enough and bright enough for me to want to try to see what is outside the bounds of present thought." Well said! [FF Ed.]

LOS ALAMOS MEMORANDUM - August 24, 1990
From: T. N. Claytor, D. G. Tuggle, H. O. Menlove

"Solid State Fusion Update - Significant Recent Results"

SUMMARY

Since the last memo we issued in April, we have achieved a milestone in our work on the gas/solid fusion systems. In both the Pd-Si-D and the Ti-D systems we can now reproducibly produce an effect. In the Ti-D cells we think that by using up to three times more Ti (300 g) and by thoroughly cleaning the Ti, deuterium and pressure bottles we can reliably get neutron yield in excess of background with almost every cell. Similarly with the Pd-

Si-D system by adding more layers to the cell and by adding a binder to the silicon powder we have achieved a tritium production rate of a factor of 7 greater than previous cells. The tritium yield from these cells is small, but when integrated over several hundred hours it can be unambiguously measured.

The parameter space for these experiments is vast and further progress will only come at the expense of more time given our low level of effort. For instance, our collaboration with the materials people at MST for tape casting, annealing and metallography, is hampered by our lack of funding. Interesting ideas concerning the use of solid state electrolytes, collaborations with others to measure the energies of the neutrons and tritons have surfaced, but cannot be pursued, seriously, without additional funding.

Menlove et. al. has submitted a paper to the *J. of Fusion Energy* on the Ti-D gas system and we are in the process of updating our LAUR 89-3946 report for submission to the *J. of Fusion Technology*. We will update the patent disclosure for the Pd-Si-D system, to reflect our current understanding of the system and to protect DOE's patent position before publication of the Fusion Energy paper. Howard [Menlove] has started the construction of a second low background counting system for use in the tunnel and the titanium dehydriding and palladium dissolution system is nearing completion. A video tape is planned so that the experiments, which take several hundred hours to complete, can be compressed to a few minutes for presentation.

Tritium Results - Pd-Si-D System

As we stated in our January and April memos, we believe the tritium production occurs near the surfaces (in the palladium), therefore we have attempted to increase the tritium yield by surface modification and by increasing the number of Pd-Si layers. While the number of alternating Pd-Si layers has been increased, the amount of palladium in each layer was reduced by nearly the same factor so that the amount of total palladium is roughly constant. As we have found before, most of the excess tritium that we measure evolves from the palladium and not from the gas phase, therefore we are confident that everything except the palladium is free of tritium contamination. All of the palladium we have used since February comes from a bottle that originally contained 260 g of S6560 powder of which 62 g (23%) has been tested for contamination at three different times. An upper limit of 0.3 nCi/g can be set on the contamination level from the control experiments. This is a factor of ten (at least) less than the excess tritium found in the recent "hot" cells 19, 20, 21.

Our improvement in tritium yield per unit time for cells 19, (0.45 nCi/h); 20 (0.6 nCi/h) and 21 (0.88 nCi/h) over the previous cell designs has been due to 1, an increase in the number of layers from fewer than 6 to 8 or more; 2, an understanding of the breakdown threshold has allowed us to operate near the maximum allowable voltage more of the time; 3, variation in the oxide thickness of the palladium; 4, the addition of a binder that consolidates and prevents the silicon from cracking while still retaining porosity.

After cell 11 we began to flow deuterium through the cell to check for tritium contamination during the initial fill. None of the cells after cell 11 have shown any contamination of the cell components by this technique. The error in tritium measurement varies with the amount of tritium measured but is usually (conservatively) about 6 nCi. It would appear that at least seven cells have shown tritium production at greater than 3 sigma. In fact, since cell 12 all of the cells have shown tritium except cell 13 (no oxide), cell 16 (shorted out), cell 18 (sulfur surface treatment) and cell 23 (D_2 control no current). The hydrogen control sample (22) requires some explanation. We have been using a gas ionization analysis system to measure gas from only these cells and the deuterium gas supply bottle with a slight amount of tritium for many months. Some equilibrium mixture of D_2 and DT is adsorbed on the walls of the analysis system. When H_2 and H_2O are introduced into the system the D_2 and DT are displaced from the walls by exchange giving a tritium signal. This signal is small and cannot account for any of our large tritium yields. We can also recognize this effect because the system takes days to finally equilibrate with the new H_2 concentration. Tritium from the gas phase of the cells produces an immediate signal that takes only a few minutes to equilibrate by mixing.

CORNELL - COLD FUSION ARCHIVE
Courtesy of Dr. Bruce V. Lewenstein

B.V. Lewenstein (Dept. of Comm., Cornell), "Cornell Cold Fusion Archive Finding Aid", Current Working Draft, Aug 13, 1990, 39 pages, 138 refs.

BACKGROUND

The Cold Fusion Archive was created with the support of National Science Foundation grant SES-891490. The program officer was Dr. James Blackman, Deputy Director, Division of Social and Economic Sciences. The grant award was made within about one month after the beginning of the cold fusion saga.

The Archive itself was created initially by the joint efforts of Dr. Bruce Lewenstein, Assistant Professor of

Communication and Associated Faculty, Cornell Program on Science, Technology, and Society (STS); Dr. Thomas F. Gieryn, visiting professor in STS; and Dr. William Dougan, postdoctoral associate in the Cornell Johnson School of Management. The collection that has been gathered is being serviced by Elaine Engst, Cornell Department of Manuscripts and Archives.

Fusion Facts has made a contribution of its first year of monthly newsletters to the Cornell Cold Fusion Archive.

LETTER FROM LEWENSTEIN

Thank you very much for the copies of *Fusion Facts* that you've recently sent to the Cold Fusion Archive. They are exactly the sort of material that makes the archive a useful collection.

We appreciate the support we've received from scientists, researchers, and others for the archive. As a token of thanks, I've enclosed a copy of the current Finding Aid describing the collection.

With best wishes, /s/ Bruce V. Lewenstein.

[We hope that the **Cornell Cold Fusion Archive** will be able to obtain the additional funding that is currently needed. The cold fusion controversy is just coming to an end. The exciting part of being involved with the most important scientific discovery of this millennium has just begun. Thanks for your good works, Bruce et al., and thanks to the NSF for their initial support. FF Ed.]

EPRI - CLUSTER-IMPACT FUSION
Courtesy of Dr. Sam Faile

Mario Rabinowitz (Electric Power Research Institute, Palo Alto, CA), "Cluster-Impact Fusion: New Physics or Experimental Error", *Modern Physics Letters B*, Vol 4, No 10, 1990, pp 665-671, 19 ref.

ABSTRACT

Deuteron-deuteron cluster-impact fusion at ~100 eV was demonstrated by Beuhler et al. Their results are analyzed to reduce a discrepancy which they note to be "more than 10 orders of magnitude", of which 10 orders or magnitude can be accounted for by compression and electron screening. Analysis is presented to show that the remaining 15 orders of magnitude discrepancy cannot reasonably be resolved by electron screening and proximity (degree of compression), or experimental errors in cluster energy and/or size.

ZERO POINT ENERGY

Moray B. King (Provo, Utah), "Can The Zero-Point Energy Be Tapped As An Energy Source?", June 1990, 60 ref. Available from the author, P.O. Box 859, Provo, UT 84603

ABSTRACT

A speculative case for tapping the zero-point energy (ZPE) arises by combining the theories of the ZPE with the theories of system self-organization. The vacuum polarization of atomic nuclei might allow their synchronous motion to activate a ZPE coherence. The observed plasma ion-acoustic anomalies as well as inventions utilizing cycloid ion motions may offer supporting evidence. The suggested experiment of rapidly circulating a charged plasma in a vortex ring might induce a sufficient zero-point energy interaction to manifest a gravitational anomaly.

SUMMARY

The intimate connection between gravity and the ZPE yields the possibility that a ZPE coherence might create a gravitational or time variation. If the suggested experiment produced a gravitational anomaly, the speculation that the zero-point energy could be tapped as an energy source would become worthy of further investigation.

EDITOR'S COMMENTS

This is not a paper about cold fusion, but it is a paper that speculates on some experimental work that could be accomplished to determine if the zero point energy could be tapped. In previous work, Moray King, has suggested that cold fusion may be related to the tapping of zero point energy. [FF Ed.]

UCLA - SCHWINGER THEORY - 2 PAPERS
Courtesy of Gene Mallove

Julian Schwinger (Dept. of Physics, UCLA), "Cold Fusion: A Hypothesis", *Zeitschrift fur Naturforschung,* Vol 45, No 5, May 1990, p 756, 2 ref.

ABSTRACT

It is suggested that the evidence for the putative phenomenon of cold fusion is valid, but that the effect is not dominated by a D D reaction.

J. Schwinger (Dept of Physics, U of CA, Los Angeles), "Nuclear Energy in an Atomic Lattice. 1", *Zeitschrift fur Physik D - Atoms, Molecules and Clusters*, Vol 15, 1990, pp 221-225, 2 ref.

COMMENTS BY ZEITSCHRIFT EDITOR

Reports on cold fusion have stirred up a lot of activity and emotions in the whole scientific community as well as in political and financial circles. Enthusiasm about its potential usefulness was felt but also severe criticism has been raised. If in such a situation one of the pioneers of modern physics starts to attack the problem in a profound theoretical way we feel that it is our duty to give him the opportunity to explain his ideas and to present his case to a broad and critical audience. We do, however, emphasize that we can take no responsibility for the correctness of either the basic assumptions and the validity of the conclusions nor of the details of the calculations. We leave the final judgment to our readers.

ABSTRACT

Evidence is presented for the assertion that an H-ion in a deuterided lattice encounters a relatively narrow Coulomb barrier before fusing to form ^{3}He.

["In this business"] "more is owing to what we call chance - that is.... to the observation of events arising from unknown causes - than to any....preconceived theory." Joseph Priestley

INTRODUCTION

In a recent note ["Cold Fusion - A Hypothesis"] I suggested that the claim of B. S. Pons and M. Fleischmann - to have released nuclear fusion energy by electrolyzing heavy water (D_2O) with a palladium cathode - could be true, except that the dominant process would be HD (p+d --> ^{3}He + Heat), rather than DD (e.g., d+d ---> ^{4}He + heat). The lattice structure of the deuterided palladium plays a vital role in this hypothesis. The presence of the ionic lattice has two effects:

1. Prior to the act of fusion, the lattice coupling diminishes the efficacy of the Coulomb barrier, in a way that strongly favors the HD process over the DD process.

2) After pd fusion begins, the liberated energy is transferred to the multiphonon degrees of freedom of the lattice, rather than to a single high energy photon.

The purpose of this paper is to begin the description of the admittedly crude theoretical considerations that led to my advocacy of the HD hypothesis.

The ultimate judgement of this hypothesis will come, of course, from the outcome of the specific experimental tests that it suggests.

CONCLUSIONS

Here, at least, is a suggestion that already at distances as large as 10 characteristic lengths, ~10^{-8} cm, the energy of attraction, $H^{(2)}$, begins to reduce significantly the Coulomb energy of repulsion.

EDITOR'S COMMENTS

Schwinger, in the first note, suggests that the claims of Fleischmann and Pons are valid; cold fusion is not a DD reaction but an HD reaction; the energy is taken up by the metallic lattice of Pd alloyed with D; the lattice coupling suppresses the Coulomb repulsion; and the asymmetry of the p-d situation enhances the HD reaction. The note mentions that the details of the lattice coupling mechanism are described in a series of papers of which the first one is reviewed above. [FF Ed.]

PURDUE - THERMONUCLEAR REACTION DATA

Larry T. Cox, Jr. (Purdue U, School of Nuclear Engineering, Indiana), Franklin B. Mead, Jr. (Astronautics Laboratory Future Technologies Section, Edwards AFB, CA), Chan K. Choi (Purdue U, School of Nuclear Engineering, Indiana), "Thermonuclear Reaction Listing with Cross-Section Data for Four Advanced Reactions", *Fusion Technology*, Vol 18, No 2, September 1990, pp 325-339, 54 ref.

ABSTRACT

Based on earlier work, all known thermonuclear reactions involving reactant particles up to and including ^{11}B are presented. The neutron-induced reactions have been eliminated, as the focus is on advanced fuels. Many new reactions have been added since the information was originally published.

CONCLUSIONS

During this initial phase of the study, much information about thermonuclear reactions and their characteristics has been accumulated. Several conclusions about available cross-section information can already be drawn. First, most of the references consulted were 10 to 20 yr old, some even older. This is attributable to a recent, genuine effort to make fusion space propulsion a reality. However, most of the data presented in this technical note are <10 yr old. Second, the safety of nearly aneutronic fuels continues to be a major factor in the push for the

development of advanced fusion propulsion. Finally, no significant work has been done since the 1950's to discover new reactions using the simple bombardment technique. It should be fairly obvious, however, that the number of reactions presented is quite plentiful. There should not be many that await discovery.

EDITOR'S COMMENTS

This article is not about cold fusion but it is judged to be an excellent reference source for our readers. The article lists all of the nuclear reactions for low mass elements up to Boron 11. [FF Ed.]

U. CA. RIVERSIDE - QUANTUM TUNNELING

E. Simanek (Dept. Phys., U of CA, Riverside), "Quantum Tunneling Through a Fluctuating Barrier. Enhancement of Cold-Fusion Rate", *Physica A* (Amsterdam), Vol 164, No 1, 1990, pp 147-168, English.

Using the method of functional integration the rate was calculated of tunneling of a quantum particle weakly coupled to a single mode of the heat reservoir. The extremal paths of the steepest descent method were obtained in the adiabatic limit, valid when the reservoir mode frequency is well below the attempt frequency of the tunneling particle. In this limit, the tunneling rate exhibits an enhancement due to the barrier fluctuation induced by the thermally excited reservoir mode. Possibly the rate of cold fusion in deuterated metals can be enhanced by fluctuations of the D-pair distance, induced by thermal phonons of the hot metal.

TEXAS A&M - CALORIMETRY DATA ACQUISITION

Omourtag Alexandrov Velev and Ramesh C. Kainthla (Texas A&M), "Heat Flow Calorimeter with a Personal-Computer-Based Data Acquisition System", *Fusion Technology*, Vol 18, No 2, September 1990, pp 351-355, 5 ref.

ABSTRACT

A heat flow calorimeter suitable for measurements with electrochemical systems was developed that allows simultaneous monitoring of up to 24 electrochemical cells with an automatic data acquisition system based on a PC-XT-type computer; a 12-bit, 8-channel analog-to-digital board; and a 16-channel expansion board. The achieved accuracy of the system was 3%.

CONCLUSIONS

A calorimetric system based on the heat flow principle has been developed that is suitable for measuring the heat output from electrochemical systems. The system can monitor up to 24 cells simultaneously. The system is accurate to within 3% for heat output ranging from 0.2 to 10 W, offers the possibility of frequent recalibration, and avoids temperature gradients in the calorimetric cell by improved stirring.

EDITOR'S COMMENTS

As we move rapidly from experimental cold fusion work in which excess heat is measured at a few percent to the ranges of 20 percent or better (which is now being achieved by several research groups), this type of computer-based calorimeter monitoring will be important. The 3% accuracy may be sufficient for the type of parameter studies that will be increasingly made to improve our collective understanding of the cold fusion electrochemical cells. [FF Ed.]

WSJ - HOT FUSION - NEARING BREAKEVEN

Jerry E. Bishop (Staff Reporter), "Future of Hot Fusion Is Boiling Down To the Behavior of a Few Helium Atoms", *Wall Street Journal*, August 31, 1990, page B1.

An inset on page B1 stated the following:

"In early October, scientists may announce that for the first time they triggered a hot fusion reaction that produces as much energy as it consumes. Researchers hope that hitting the break-even point will not only mark a scientific milestone but will rejuvenate public and congressional interest in hot fusion".

EDITOR'S COMMENTS

Bishop points out that after $11 billion and 35 years worth of scientific research, the hot fusionist may be able to demonstrate the production of as much energy as being consumed. The achievement could come either from Princeton or from a similar research team working in England [probably at Harwell]. The attempt to light a fusion fire requires over one million degrees and one of the "lighters" is the $360 million Compact Ignition Tokamak, now on the drawing board.

We would like to suggest that if the same effort that has been expended in trying to deny the reality of cold fusion had been put into understanding cold fusion, a better understanding of hot fusion would have been achieved. It is likely that the rapid advances now being made in

improving our understanding of nuclear fusion in a metal lattice will lead to a better understanding of how to harness hot fusion. [FF Ed.]

LIVERMORE - QUARK ENERGY
Courtesy of Dr. Samuel Faile

Charles Alcock (Inst. of Geophysics, Livermore Nat'l Lab), "Engineering with Quark Matter", *Nature,* vol 337, Feb 2, 1990, p 405, 6 ref.

EDITOR'S COMMENTS

It is proposed that high-energy heavy-ion collisions might make small quark nuggets. Such a nugget could be captured and stored. The possible "growth" of such nuggets by the addition of low energy neutrons would yield 20 MeV per neutron. This may be a potential energy source. We would like to suggest to the Editor of *Nature* that similar nuclear events captured in a Pd lattice appear to be about as energetic. Now that cold fusion has been demonstrated by over 60 laboratories, maybe *Nature* ought to revise their unscientific policy of dismissing any positive results of cold fusion.

1923 HISTORICAL PAPER - Pd HYDRIDE
Courtesy of Dr. Gene Mallove, MIT

L. W. McKeehan (Affiliation may have been with Frank. Inst.), "The Crystal Structures of the System Palladium-Hydrogen", *Physical Review*, Vol 21, 1923, pp 334-339, 15 ref plus bibliography 1900-1921 of over 60 refs.

ABSTRACT

Crystal structures of the system palladium-hydrogen - Palladium in the form of a fine wire, 1/4 mm diam., or of a narrow strip 1/20 mm thick, was more or less saturated with hydrogen and used to diffract x-rays of known wave-length as in the well-known powder method. Two crystal structures were present, both having a face-centered cubic arrangement of atoms. One, that of pure palladium, has a parameter 3.900 X 10^{-8} cm, while the other, that of hydrogen-saturated palladium, has a parameter varying between 4.000 and 4.039 X 10^{-8} cm, depending on the degree of saturation. A value near the upper limit, say 4.036 X 10^{-8} cm, probably corresponds to a compound Pd_2H, with a density of 10.76 gm/cm^3. The arrangement of atoms may be as in Cu_2O, but there is no x-ray evidence for the positions of the hydrogen atoms. **Stability.** All the evidence so far obtained indicates that in the absence of sufficient free atomic hydrogen, the saturated state is unstable or metastable and that return to the hydrogen-free condition once initiated in any crystal proceeds rapidly to the end; also pure palladium is unstable in the presence of atomic hydrogen.

Occlusion of hydrogen by palladium - A necessary condition is the presence of atomic hydrogen which may be supplied by electrolysis or by surface dissociation of hydrogen at high temperatures. The penetration into the wire was shown to be relatively slow; in the case of the strip it was somewhat irregular, probably depending on the orientation of the crystals. The crystal evidence provides an explanation of the variations of electric resistance. A bibliography of 66 titles, mostly 1900-1921, is appended.

EDITOR'S COMMENTS

Note that McKeehan suggests that atomic hydrogen can be supplied by electrolysis. He also notes the variation of electrical resistance as being a function of the crystalline changes. Some cold fusion experimenters are making good use of the change of resistance to determine the degree of loading of Pd with deuterium in an electrochemical cell. [FF Ed.]

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E. NEWS FROM ABROAD

AUSTRALIA - PLASMA MODEL

H. Hora and L. Cicchitelli (Dept. of Theoretical Physics, U of New South Wales, Kensington, Sydney, Australia), G. H. Miley and M. Ragheb (Fusion Studies Laboratory, U of Illinois, Urbana), A. Scharmann and W. Scheid (Fachbereich Physik, U of Giessen, B. R. D.), "Plasma and Surface Tension Model for Explaining the Surface Effect of Tritium Generation at Cold Fusion", *Il Nuovo Cimento*, Vol 12D, No 3, March 1990, pp 394-399, 16 ref.

SUMMARY

For explaining the surface mechanism of deuterium reactions in palladium and titanium (cold fusion or neutron swapping) leading to strong tritium production and isotope shifts in palladium, the mechanism of an exotic deuterium plasma with possible short nuclear distance by thermal motion was introduced. Using a new model of the surface tension of metals, resulting in a swimming electron layer, the increase of the concentration of deuterons and the decrease of their distance cause a higher cold fusion in the surface layer by orders of magnitudes compared with the bulk material.

EDITOR'S COMMENTS

Modeling done in this paper also suggests that increased screening can increase the deuterium density in the surface layer up to two-fold. Also, maintaining the cleanliness of the surface (i.e. suppressing any poisoning by Li, S, etc.) is suggested as being important. [FF Ed.]

CANADA - TRITIUM STORAGE
Courtesy of Dr. Samuel Faile

W. T. Shmayda, A. G. Heics and N. P. Kherani (Ontario Hydro Research Division, Ontario), "Comparison of Uranium and Zirconium Cobalt for Tritium Storage", *Journal of the Less-Common Metals*, Vol 162, 1990, pp 117-127, 14 ref.

SUMMARY

The utility of ZrCo for tritium storage has been studied and a comparison with uranium has been made. Loading, unloading, and delivery operations typically required in tritium handling loops were conducted using two identical beds: one containing 25.0 g of ZrCo and the other 25.8 g of uranium powder. Hydrogen was the working gas. The two beds have similar performance characteristics although the bed containing uranium has faster loading kinetics and can attain a lower vacuum at room temperature. Particulates are transported into the loop by both beds and appear to be more difficult to contain in the ZrCo case. The temperature ramp rate to the unloading temperature for ZrCo must be controlled if operating at high H/M ratios. A transformation of the ZrCo alloy into a phase which has inferior loading rate characteristics may be induced by rapid temperature ramping.

CZECHOSLOVAKIA - N-P INTERACTION THEORY

J. Kvasil, A. K. Jain, R. K. Sheline (Dept Chem. Florida State U), "Neutron-Proton Interaction and Band Crossing in the Cranking Model", *Czech. J. Phys.*, Vol 40, No 3, 1990, pp 278-300, English.

ABSTRACT

A cranked Hartree-Fock-Bogolyubov formalism for a description of collective rotational states, which includes the n-p residual interaction along with pairing and is applicable to a n-p system, is presented. A δ force form is used for the n-p residual interaction. A simple model is then developed where the valence n and the valence p occupy $i_{13/2}$ and $h_{11/2}$ orbitals, respectively. Results of these calculations are presented to show the effect of n-p interaction on the phenomenon of band crossing. Within the limits of such a restrictive model (which is particularly applicable to the $(h_{11/2})p(i_{13/2})n$ bands in odd-odd nuclei), evidence is found for a shifting of the 1st band crossing frequency to a larger value. The n-p interaction may also affect many other phenomena in the high spin region.

FRANCE - NEGATIVE REPORT IN ION BOMBARDMENT TEST

J. P. Briand, G. Ban, M. Froment, M. Keddam, F. Abel (Inst. Radium, Univ. Pierre et Marie Curie, France), "Cold Fusion Rates in Titanium Foils", *Phys. Lett. A*, Vol 145, No 4, 1990, pp 187-91, English.

ABSTRACT

A new sensitive test (10^{-12} W cm^{-3}) of cold fusion in Ti charged by D was carried out. The penetration of D into Ti foils, in the presence of metallic salts (like in the experiments of Jones, S. E. et al., 1989) was checked and is inefficient; the quoted fusion rates are correspondingly larger by orders of magnitude. Experiments in different experimental conditions in which the D penetration was under control were performed. So far no cold fusion event was found.

GERMANY - CLUSTER IMPACT

Jochen Fricke (Fed. Rep. Germany), "Fusion With Fast Deuterium Oxide Clusters", *Phys. Unserer Zeit*, Vol 21, No 2, pp 61-62.

ABSTRACT

A review with 2 refs. dealing with a new fusion method in which a D containing target is bombarded with fast D_2O clusters. Three MeV p are generated in the fusion reaction $^2H + {}^2H \rightarrow {}^1H + {}^3H$ but the yield is not sufficient for technical applications yet.

GERMANY - NEGATIVE REPORT IN ION BOMBARDMENT TEST

J. Roth, R. Behrisch, W. Moeller, and W. Ottenberger (Max-Planck-Inst. Plasmaphys., Euratom-IPP Assoc., Germany), "Fusion Reactions During Low Energy Deuterium Implantation into Titanium", *Nucl. Fusion*, Vol 30, No 3, 1990, pp 441-446, English.

ABSTRACT

In the search for cold fusion reactions in solids loaded with D atoms at high concentration, ion implantation was

used as a means to reach the required high D concentration in the lattice. D^+ at 0.3-6 keV was injected into 3 micrometer thick Ti foils at room temperature and at 140 K. The p from the D(d,p)T reaction were monitored using a solid state detector with a large solid angle, both during and after implantation. After implantation of D in the Ti foil up to saturation, i.e. with ~1.8 D atoms per Ti atom at room temperature, the possible fusion reaction rate at equilibrium was determined over a period of 65 h. The measured count rate was within the limits of the natural background, and an upper limit of 1×10^{-23} per D pair s^{-1} was established. During implantation of D at energies 3-6 keV, the count rate is dominated by reactions of the incident energetic d with d already implanted in the foil. The D-D reaction cross sections, evaluated at 140 K, follow those obtained by extrapolation of the Gamow function to low energies. During implantation of 300 eV D+, no counts from the D(d,p)T reactions were monitored, showing that even under extreme conditions of nonequilibrium the possible cold fusion reaction rate is smaller than the background count rate.

INDIA - SCREENING

V. C. Sahni (Nucl. Phys. Div., Bhabha At. Res. Cent., India), Comment on "Cold Fusion in Condensed Matter: is a Theoretical Description in Terms of Usual Solid State Physics Possible?", *Nucl. Phys. B*, Vol 336, No 1, 1990, pp 86-99, English.

ABSTRACT

A polemic. W. Schommers and C. Politis (ibid., 1989, 3, 597) concluded that at r approximately <1 Angstrom separation of D in Pd, electronic screening effects lead to an attractive potential between D's, so that cold fusion can occur. The shape of the 2-body potential (2 BP) sketched by Schommers and Politis is in error, and at r approximately <1 Angstrom the 2BP will not be attractive, but will be repulsive. A possible pathway for cold fusion via metallic screening effects of the usual type is untenable; other types of solid state effects are not ruled out.

ITALY - SCREENING

L. Bracci, G. Fiorentini, G. Mezzorani (Dip. Fis., INFN, Italy), "A Dynamical Calculation of the Electron Shielding for Deuteron-Deuteron Fusion", *Phys. Lett. A*, Vol 146, No 3, 1990, pp 128-133, English.

ABSTRACT

A dynamical calculation is presented of electron screening for d-D nuclear reactions, in the energy range relevant for star interior and fusion reactors, in the framework of the classical trajectory Monte Carlo method. The numerical results, in the limit of low and high velocity, agree with the quantum mechanical values derived within the adiabatic and sudden approximations, respectively. Corrections to the bare nucleus cross sections >10% are found for c.m. energies <1 keV. As a check of the calculation method, the large-angle electron transfer probability was evaluated.

ITALY - PLASMON-ENHANCED FUSION

M. Baldo (Instituto Nazionale di Fisica Nucleare, Sezione di Catania Corso Italia, Italy), R. Pucci (Dipartimento di Fisicia e G.N.S.M., Unita di Catania, Italy), P. F. Bortignon (Instituto di Ingegneria Nucleare, Politecnico di Milano Via Ponzio, Italy and Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Italy), "Relaxation Toward Equilibrium in Plasmon-Enhanced Fusion", *Fusion Technology*, Vol 18, No 2, September 1990, pp 347-350. 13 ref.

ABSTRACT

The approach to equilibrium of a deuteron gas absorbed into a metal is considered in the framework of a model in which the crystal is described in terms of its elementary excitations. The deuteron-deuteron interaction is dominated by the plasmon exchange; while the relaxation to equilibrium is mainly due to the coupling with the phonons. The particle-hole contribution is smaller than the plasmon contribution, but not negligible. The time evolution of the deuteron gas, after a first stage dominated by quasi-free scattering, is characterized by the relaxation toward the formation of quasi-deuterium molecules. During this evolution toward equilibrium, fusion reactions can take place at an experimentally detectable rate, while at equilibrium the fusion rate is quite small and comparable with the one for free deuterium molecules.

CONCLUSIONS

We have also considered the contribution to the deuteron self-energy due to particle-hole excitations. Although this contribution does not exceed 30% of the plasmon one, introduction makes it possible to reproduce the experimental fusion rate using more realistic values of the plasmon cutoff momenta. Unfortunately, the latter are not known experimentally. Furthermore, the introduction of the particle hole coupling in the model fulfills Kato's theorem.

EDITOR'S COMMENTS

This paper is another example of the serious work on cold fusion coming from Italy. *Fusion Facts* would be interested in having these scientists discuss their work with Prof. Guiliano Preparata, who has also been contributing to the theory of cold fusion with his superradiance model. We would be pleased to publish short comments on these two Italian approaches to the theory of cold fusion. [FF Ed.]

JAPAN - VERIFICATION OF NATTOH MODEL

Takaaki Matsumoto (Hokkaido U, Dept of Nuclear Engineering, Japan), "Observation of New Particles Emitted During Cold Fusion", *Fusion Technology*, Vol 18, No 2, September 1990, pp 356-360, 6 ref.

ABSTRACT

To confirm the emission of the "iton" particles predicted by the Nattoh model, a cold fusion experiment based on electrolysis of heavy water has been performed. The tracks of several kinds of itons have been successfully recorded on nuclear films. The formation and decay mechanisms of itons are included in the Nattoh model.

EXPERIMENT

To observe the emission of itons, a cold fusion experiment with heavy water has been performed. The induction of hydrogen was based on electrolysis. A 5-mm-diam X 50-mm palladium rod was used as the cathode. The material was kept in vacuum at a temperature of ~800 deg C for >12 h for gas discharging. A 0.5-mm-diam platinum wire anode was wound around the cathode helically. Heavy water added to 3% NaCl was used as the electrolyte solution and contained in a 60-mm-diam glass cell. The experiment was performed at room temperature. The current was 0.7 A and the bias 5 V.

CONCLUSIONS

The emission of itons has also been recognized in a similar experiment with ordinary water (Matsumoto, "New Particle 'Iton' Emitted on Cold Fusion with Ordinary Water"--to be published). Therefore, we have proven that a hydrogen-catalyzed fusion reaction, which emits no neutrons, actually occurs in cold fusion and that the Nattoh model can properly explain the mechanism of cold fusion.

EDITOR'S COMMENTS

Fusion Facts would like to hear from any other scientists who have replicated Professor Matsumoto's work. This is the first published report that we know of that has used nuclear film to record cold-fusion particle tracks. It is important that the theory and the experimental work to verify theories are now being reported. We are especially pleased with Dr. Matsumoto because he has been kind enough to provide *Fusion Facts* with news from Japan as one of our correspondents. [FF Ed.]

JAPAN - ABSORPTION MEASUREMENTS
Courtesy of Dr. Samuel Faile

Noboru Oyama, Nobushige Yamamoto, Osamu Hatozaki and Takeo Ohsaka (Dept of Applied Chemistry, Faculty of Technology, Tokyo University of Agriculture & Technology, Koganei, Tokyo), "Probing Absorption of Deuterium into Palladium Cathodes During D_2O Electrolysis with an *In Situ* Electrochemical Microbalance Technique", *Japanese Journal of Applied Physics*, Vol 29, No 5, May 1990, pp L818-L821, 18 ref.

ABSTRACT

The *in situ* observation of the absorption of deuterium (or hydrogen) into the Pd cathode during D_2O (or H_2O) electrolysis was made by an electrochemical microbalance technique which is based on the quartz-crystal electrode. The resonant frequency of the Pd-coated quartz-crystal electrode decreased with increasing amount of charge passed during electrolysis, and the frequency change for the D_2O electrolysis was about twice that for the H_2O electrolysis. The atom ratios of H/Pd and D/Pd of the H-Pd and D-Pd compounds resulting from the electrolysis were estimated to be 0.59 and 0.57, respectively.

JAPAN - REVIEW

Kanetada Nagamine (Science College, Tokyo U), "Muon Catalyzed Fusion", *Kino Ziryo*, Vol 10, No 1, 1990, pp 11-15, 4 ref.

ABSTRACT

A review with 4 refs. is given on room temp. nuclear fusion, muon-catalyzed nuclear fusion, recent experimental research, and the future prospect of muon-catalyzed nuclear fusion.

JAPAN - HEAT AND NEUTRONS

Eiichi Yamaguchi, Takashi Nishioka (Basic Res. Lab., NTT, Japan), "Cold Nuclear Fusion Induced by Controlled Out - Diffusion of Deuterons in Palladium", *Jpn. J. Appl. Phys., Part 2*, Vol 29, No 4, 1990, pp L666-L669, English.

ABSTRACT

A gigantic n burst of (1-2) X 10^6 n/s was detected from deuterated Pd plates with heterostructures set in a vacuum chamber. An explosive release of D_2 gas, biaxial bending of all the samples, and excess heat evolution were observed at the same time. These phenomena are caused by the cooperative production of D accumulation layers at Pd surfaces due to controlled out-diffusion of D atoms.

NETHERLANDS - HYDROGEN ABSORPTION
Courtesy of Dr. Samuel Faile

K. H. Buschow, H. H. Van Mal and A. R. Miedema (Philips Research Laboratories, Eindhoven, The Netherlands), "Hydrogen Absorption in Intermetallic Compounds of Thorium", *Journal of the Less-Common Metals*, Vol 42, 1975, pp 163-178, 22 ref.

SUMMARY

The formation of ternary hydrides has been studied for 15 intermetallic compounds of thorium, (five compounds in each of the systems Th-Ni, Th-Co and Th-Fe). With the exception of the compounds richest in 3d-metal, they all form hydrides by reaction with hydrogen gas at room temperature. The hydrides prepared include the compounds $ThCoH_4$, $ThNi_2H_5$ and $Th_7Ni_3H_{28}$. Some compounds ($Th_2Co_7H_4$, $Th_2Fe_7H_5$) have equilibrium hydrogen pressures near to 1 atmosphere at 300 K.

The results are discussed in terms of a model that predicts the enthalpy of formation of a ternary hydride from the knowledge of delta H for the corresponding binary hydrides and binary intermetallic compounds.

In addition we discuss experimental results on hydrogen absorption in $LaNi_5$ and related compounds, published earlier. The agreement between model predictions and experiment is quite convincing.

CONCLUSIONS

The present experiments on hydrogen absorption in thorium compounds, together with the experimental data for $LaNi_5$-type intermetallic compounds reported previously, support the idea that the energy effects in metallic hydrides are predominantly nearest-neighbor effects.

The property of intermetallic compounds in being able to absorb large quantities of hydrogen at room temperature is found to be quite general; the crystal structure is relatively unimportant. It is necessary that the compound should contain a metallic element (metal) which forms a stable, binary hydride; in addition, this binary hydride should clearly be more stable than the intermetallic compound.

H. H. Van Mal, K. H. J. Buschow and A. R. Miedema (Philips Research Laboratories, The Netherlands), "Hydrogen Absorption of Rare-Earth (3d) Transition Intermetallic Compounds", *Journal of the Less-Common Metals*, Vol 49, 1976, pp 473-475, 5 ref.

SUMMARY

Recently, we reported on the hydrogen absorption behavior of a large number of compounds formed between rare-earth metals or thorium (R) and elements of the 3d transition group (M). Special attention was paid to those compounds in which R is the minority element. The tendency of these compounds to form hydrides can be predicted from a simple model; hydride formation is easier the less stable the compound one starts from. Quite generally, model predictions and experimental results for the heat of formation of hydrides are found to agree. Furthermore the fact that the simple model applies to a variety of intermetallic compounds indicates that the crystal structure of the compounds does not have much effect on the enthalpy of hydrogen absorption, i.e., the $CaCu_5$ type (and the related stacking variants) should not be regarded as possessing unique features in this respect.

In the present investigation, we extend our previous work on rare-earth 3d metal compounds to also include compounds richer in R metal than RM_5, and compounds in which M is Fe or Mn.

POLAND - CONDUCTING TESTS

Jerzy Zak (Inst. Chem. Technol. Nieorg., Poland), "Low-Temperature Fusion of Light Nuclei in the Fleischmann-Pons Reaction", *Inz. Apar. Chem*, Vol 28, No 5, 1989, pp 3-4, Polish.

ABSTRACT

A discussion with 3 refs. is given on radiation observed during an electrolysis of D_2O with a Pd cathode. The properties of D in the crystal lattice of Pd are described.

The possibility of electrochemically-induced cold fusion is discussed.

ROMANIA - DEUTERIUM IN $LaNi_5$
Courtesy of Dr. Samuel Faile

A. Biris, R. V. Bucur, P. Ghete, E. Indrea and D. Lupu (Institute of Stable Isotopes, Romania), "Solubility of Deuterium in $LaNi_5$", *Journal of the Less-Common Metals*, Vol 49, 1976, pp 477-482, 7 ref.

SUMMARY

The pressure-composition isotherms for the systems $LaNi_5$-H_2 and $LaNi_5$-D_2 have been measured both for absorption and for desorption in the temperature range -10 to 65 degrees C. The ratio of the plateau pressures, $r = P_{H2}/P_{D2}$, is $r < 1$ at high temperatures, and becomes $r > 1$ at lower temperatures, depending on the thermal treatment of the sample. From the plateau pressures at a constant hydrogen (or deuterium) concentration in $LaNi_5$ (3 D or 3 H atoms/mole of $LaNi_5$) the partial molar enthalpies, heat of formation, and entropies delta S of formation are calculated. Lower (more negative) values have been obtained for deuterium both for delta H and for deltas S.

USSR - FUSION IN SOLUTIONS

S. Yu Karpov, Yu. V. Koval'chuk, V. E. Myachin, Yu. V. Pogorel'skii (Fiz.-Tekh. Inst. im. Ioffe, Leningrad, USSR), "Possible Mechanism of Cold Nuclear Fusion", *Pis'ma Zh. Tekh. Fiz*, Vol 16, No 5, 1990, pp 91-94, Russian.

ABSTRACT

An hypothesis is presented concerning the mechanism of the effect observed earlier of the emission of neutrons from Pd saturated with D in the electrolysis of heavy water. As a consequence of this hypothesis, a possible change in the experimental setup is possible. The feasibility was examined of the penetration of a proton (or a deuteron) into the inner shell of a heavy atom. The emission of neutrons is related to the fusion of deuterons approaching each other at small distances within the electron shells of the heavy atoms. In connection with this, a number of chemical reactions were conducted on the formation of acid solutions of electrolytes in heavy water, e.g. the dissolution of HBr (10-15 mL of a 40% aqueous solution) in a KI-saturated solution in D_2O (20 mL, 99.9%). The same reaction was conducted in ordinary water as a control. Cold nuclear fusion is supposedly observed in the D_2O solution, as evidenced by the neutrons recorded up to and during the course of the chemical reaction.

EDITOR'S COMMENTS

It is a challenging idea - that some nuclear reactions could occur in a chemical solution without the benefit of either Pd or electrolysis. Historically, a French scientist supposedly found that certain biological species could transmute certain chemicals to obtain a required but deficient nutrient. I have forgotten the reference. Suffice to say, his findings went unpublished in scientific journals. [FF Ed.]

USSR - THEORY

V. P. Permyakov, V. M. Shilov (Ob'edin. Inst. Yad. Issled., USSR), "Subbarrier Fusion of Complex Nuclei", *Fiz. Elem. Chastits At. Yadra*, Vol 20, No 6, 1989, pp 1396-1438, 110 ref, Russian.

ABSTRACT

Theoretical models for describing cross sections of the complete fusion of light and medium nuclei at subbarrier and near-barrier energies are considered. The multichannel model with ingoing-wave boundary conditions in the inner nuclear region is discussed in detail; various implications of the model are considered. The elastic and inelastic cross sections are treated on the same footing; the decay properties of a compound nucleus are discussed. The results are compared with experimental data.

USSR - COLD FUSION

B. V. Govorov, V. M. Gryaznov, N. V. Eremin, AS. N. Karavanov, N. R. Roshan, A. F. Tulinov, I. V. Tyapkin (Inst. Neftekhim, Sint. im. Topchieva, USSR), "Study of Neutron Emission from Palladium Saturated with Deuterium", *Zh. Fiz. Khim.*, Vol 64, 1990, No 2, pp 539-540, Russian.

ABSTRACT

The process $D + D \rightarrow {}^3He + n$ was investigated under conditions of the saturation of Pd alloys with gaseous D_2. Pd-Sm (80% of Pd) and Pd-Ru (94% of Pd) were used. These alloys absorb actively H_2 at atmospheric pressure and temperatures < 370 K, with forming a hydride phase rich in H. Pd-Ru membranes can operate for ~2000-3000 hours, whereas Pd-Sm membranes are disintegrated in several hours. For the study of the neutron emission, powderized samples (of ~2 g) with a particle diameter of

~1 mm were situated into a U-tube. D_2 was allowed to stream through the tube at an atmospheric pressure with a rate of ~10 mL/min. The samples were preliminarily activated by heating at 500 K. The neutrons were detected by 12 proportional counters filled with ^3He. The U-tube was surrounded by 30 $(C_2H_4)_x$ blocks serving as moderators. The probability of detecting a single neutron, as established with the use of a ^{252}Cf source, was of 0.105 ± 0.005. The results of measuring the neutron yield during the thermal treatment of Pd-Sm are shown. A short-term neutron flare was observed when achieving T = 500 K. An analogous situation was observed with the Pd-Ru. No increase of the neutron yield was observed when using a stream of H_2. The average excess of neutrons above the background in the maximum at 500 was of 1.8 ± 0.3 and 1.9 ± 0.3 for Pd-Sm and Pd-Ru, respectively. The disintegration of metals during their saturation with H_2 plays no substantial role in the cold thermonuclear synthesis when assuming the neutron yield to result from the above mentioned process.

YUGOSLAVIA - PARTIAL REPLICATION

S. Miljanic, N. Jevtic, S. Pesic, M. Ninkovic, D. Nikolic, M. Josipovic, Lj. Petkovska, and S. Bacic (Boris Kidric Institute of Nuclear Sciences, The Center for Fusion Research Vinca, Yugoslavia), "An Attempt to Replicate Cold Fusion Claims", *Fusion Technology*, Vol 18, No 2, September 1990, pp 340-346, 6 ref.

ABSTRACT

An attempt was made to replicate electrochemical and gas-load cold fusion neutron counts. The best results for electrolysis were counts of 2.5 times background for 45 min. The cold fusion rate was found to be $<2.09 \times 10^{-22}$ fusion/(d-d) x s^{-1}. For the gas-load method, an effect was seen twice, with neutron counts on the order of 3 to 4 times background over 1.5 h. The search for excess tritium in the heavy water from the electrolytic cells proved negative. However, mass spectroscopy of the D_2 gas before and after the gas-load experiments indicated a change in the mass 3 to mass 2 ratio from 0.53 to 1.66.

CONCLUSIONS

The spectacular results reported by Fleischmann and Pons and the Frascati group were not replicated. Counts of 2.5 times background over 45 min on the 12-in. Bonner sphere in the electrochemical experiments and 3 to 4 times background neutron counts over 1.5 h on the BF_3 dosimeter in the gas-load experiments were obtained. The cold fusion rate in the electrolytically charged cast palladium was estimated at $<2.09 \times 10^{-22}$ fusion/(d-d) x s^{-1}. This warrants further work toward confirmation or refutation, as is also indicated by the inconclusive tritium and mass spectroscopical measurements.

EDITOR'S COMMENTS

We welcome these Yugoslavian scientists to the cold fusion club. We suggest that this work (paper received March 12, 1990) be compared with the latest work done by Menlove et al. and by Claytor et al. at Los Alamos. In addition, the work by Yamaguchi in Japan provides an improved means by which neutrons can be produced. The latest report on Claytor and Yamaguchi's work was reported in the August issue of *Fusion Facts.* We commend these scientists for their efforts and hope they will modify their experiments to take advantage of some of the improved techniques being developed. Hope to hear more soon from Yugoslavia. [FF Ed.]

* *

F. IMPACT ON ENERGY POLICY

By Hal Fox, Editor

Maybe the science of cold fusion hasn't "come of age" but it certainly wasn't stillborn. More like an early teenager, with the discovery that a molten salt cold fusion cell can produce six to twelve times the amount of excess energy [1]. As contrasted with the many years of development of hot fusion, where after the expenditure of $11 billion, energy out has not equalled energy in, as yet, cold fusion now shows some commercial promise. A cold fusion reactor should provide about three times the amount of energy out as compared to energy in to show commercial promise. With 300% excess energy, one could make a case for the use of high-priced electrical energy to produce low-cost heat using cold fusion reactors. At 300% excess energy, the output energy makes the device competitive with natural gas for heating applications. At 500% or more of excess energy, we have to recognize this development as an energy breakthrough having great commercial potential.

If it is assumed that the invention of Liebert and Liaw [1] can be replicated and that the reactor cell longevity can be increased, then this molten salt fusion reactor has near-term commercial applications. If this is true, what then is the expected impact of this discovery on America's energy policy and what should we do?

U. S. CURRENT ENERGY POLICY.

In a recent conversations with DoE officials in the Policy division, it was admitted that the U.S. does not, as yet, have a well-defined energy policy. There are a variety of energy tasks and activities being directed from various

divisions within DoE. After some 14 months of public hearings, DoE is now putting together an energy memorandum for delivery to President Bush in December 1990. The memorandum will contain various approaches and options that, after appropriate presidential inputs, will become the nations's energy policy.

It is not surprising that the U.S. government energy position has been shown to be ineffective in reducing the U.S. energy dependency on oil imports. Previously there was a strong effort made to reduce energy consumption by a variety of energy conservation measures. With the current crisis in the Persian Gulf, there is a resurgence of media articles proclaiming the virtues of reducing our dependency on foreign oil. Unfortunately, neither the media nor the current DoE officials are aware of the remarkable new developments in cold fusion. This new technology has the highest potential of providing the U.S. with energy independence than any other resource. Our energy policy must recognize this scientific and engineering fact.

If the $500 million per year that has been spent on the development of hot fusion resulted in the production of excess energy, **that would be NEWS**. The fact that a cold fusion molten salts reactor produces over six times as much energy as it consumes must be unbelievable to the media [1]. With this energy breakthrough, and other new fusion developments, media recognition is expected to improve.

FUTURE ENERGY POLICY

In the traditional American way, this discovery is expected to be expanded into commercial products by several existing or newly-formed American companies. Therefore, cold fusion will have an impending impact on the U. S. energy policy. Here are some of the ways in which this new development will (or should) impact our energy policy:

1. As soon as new energy sources are developed, the burning of petroleum products should be strongly discouraged. Crude oil should be saved as feedstocks for the petrochemical industry.

2. The U.S. should plan for a phased transition to the use of cold fusion reactors. This transition should be supported by tax breaks with legislation similar to laws used to promote the use of non-petroleum gasoline additives (methanol, ethanol, etc.).

3. Legislation should be passed to allow industry to write-off the cost of fusion energy reactors. In other words, a 100% depletion allowance should be allowed during the first year of use. Obviously, this is a method of providing tax dollars to help pay the cost of installation of new energy sources. The savings are expected to be made up by lessening the impact of energy use on the environment.

4. Legislation should be passed to allow investors to retain any capital gains with no tax penalty, provided that the capital gains comes from an investment in cold fusion. This action would spur investment in cold fusion developments.

5. Because the word "nuclear" implies something "bad" to the general public, a strong educational effort should be launched to tell the truth about the non-polluting, non-radiation effects of cold fusion nuclear reactors. Except for some tritium being produced in the electrolyte (which is easily handled in a closed cell), a properly-designed cold fusion cell (i.e. one designed to eliminate neutron emission) produces no harmful radiation.

6. The U.S. should immediately stockpile palladium and lithium because these two elements are crucial to the development of cold fusion energy in its present form. Titanium has also been used to provide excess energy in cold fusion cells and should also be considered as a critical product.

7. Legislation should be passed to not only permit but also to promote the association of American companies to work closely together on the research and development of cold fusion. However, after commercial products have been defined the companies should compete with each other. This is the technique used by Japan to hasten the development of new technology but also to retain competition. Current U.S. laws provide legal restraint that prevents corporations from working together to develop new technology.

8. The Department of Energy should sponsor a symposium on cold fusion and ensure that the audience includes the officers of the American Physical Society and all of the many prestigious U. S. scientists who tried and failed to replicate cold fusion. The symposium should include working demonstrations of the latest technology such as Claytor's tritium-producing cells and the best available energy-producing electrochemical cell.

9. The Department of Energy should establish a Cold Fusion Interagency Office to coordinate with all other government agencies who have interest in energy use. (Examples would be Agriculture, DoD, Labor, Education, EPA, Health & Human Services, National Science Foundation, and Interior).

10. Because the transition from conventional to cold fusion energy will cause enormous disruptions in industry, especially as old technology is phased out, legislation should provide for retraining of displaced workers.

11. All United Nations projects, World Bank loans, and Aid for International Development loans should require the use of non-polluting energy sources and educational and training modules for using these energy sources.

12. Government contracts should have a provision for favoring contractors who use or install cold fusion energy systems.

13. A special tax should be assessed on all energy-consuming units that use hydrocarbons, fossil fuels, or electricity derived from generating plants in which fossil fuels are used. This tax would promote the use of cold fusion energy systems and also pay for the retraining programs.

14. During the phaseover from hydrocarbon fuels to cold fusion reactors, the known oil resources of the United States should be carefully developed (meaning with full attention paid to the protection of the environment). This step should be accompanied by a $5 per barrel surcharge on any imported fuel except the fuel purchased for storage in our national oil reserve pool.

Note: All of the above legislated benefits would not cost nearly as much as the current costs of defending the Persian Gulf.

RETRAINING REQUIREMENTS

It is predicted that the commercialization of cold fusion will have a larger impact on business and industry (world-wide) than any previous technology. Many new companies will be formed to provide for the enormous changeover from conventional to cold fusion energy systems. Many older companies will fold or be required to make extensive changes to adapt to this new technology. Many workers will be temporarily discharged.
The retraining of displaced workers will become a national priority at some time in the future. Therefore, it would be proper to begin now to plan for the retraining of these displaced workers. For example, the changeover to fusion-energy battery-operated automobiles will have an enormous impact on the entire transportation business. From service stations to automobile assembly plants, there will be great changes. It is expected that the polluting internal combustion engine will be replaced with the development of cold fusion reactors to charge electrical batteries to power the fusion electric cars of the future. Thousands of engine mechanics will have to be retrained.

INTERNATIONAL CHANGES

One of the greatest impacts of the development of fusion energy systems will be the gradual replacement of the use of oil products. This changeover will strongly affect the international flow of money. Third world countries, in particular, will be able to divert oil funds to funds used to develop internal energy resources where the fuel is heavy water (deuterium) and lithium. Nations that do not produce palladium will probably have to spend funds to import palladium. However, current experiments with titanium may demonstrate that this lower-cost metal can be effectively used in cold fusion cells.

OIL DEVELOPMENT - ALASKA AND U.S.

About 25% of U.S. daily oil production comes from the Alaska North Slope oil fields. Originally, this oil discovery had 11 billion barrels of recoverable oil and gas-related liquids. That amount of recoverables is now down to 4.5 billion barrels. The Prudhoe oil field is now declining from 1.5 million barrels a day to an estimated 400,000 barrels a day in the year 2000.

Other oil fields are expected to exist in this area. For example, the Alaska coastal plain of the Arctic National Wildlife Refuge is expected to hold another major oil field. In the light of our current oil dependency and our future changeover to cold fusion power, all known oil reserves should be developed. This development will lower our national dependence on foreign oil and also contribute strongly to our national balance of payments. [See reference 2.]

Although oil spills have done environmental damage, one forest fire does far more environmental damage than all of the damage done by oil drilling. Although great precautions should be taken to protect wildlife, we cannot allow both humans and wildlife to be placed in jeopardy by failure to develop alternate energy resources. Neither should we allow foreign oil purchases to continue with such strong negative impacts on our nation's economic health.

CONTACTS WITHIN THE DEPARTMENT OF ENERGY

Dr. Walter Polansky is the acting director of the Division of Advanced Energy, ER-16, U.S. DoE, Washington, D.C. 20585. Telephone: 301/353-5995. This group is "the contact point for cold fusion". Funds are currently being provided to Dr. Claytor (Los Alamos); Dr. Steven Jones (BYU); and Dr. Weismann (Brookhaven) for cold fusion investigations.

Other DoE officials who should be informed of any breakthroughs in cold fusion are the following:

Dr. Bob Simon, Special Assistant to Secretary Watkins, U.S.DoE, telephone: 202/586-7092.

Dr. Linda Stuntz, Under Secretary for Policy, U.S.DoE, telephone: 202/585-5316

Bill Hatch (reports to Dr. Stuntz), TE-4, Room 7H602, Wash. D.C. 20585, telephone: 202/586-5316

Bob Marley, Office of Policy, (PE-61), U.S.DoE, Wash. D.C. 20585, telephone: 202/586-3900

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* *

G. SHORT ARTICLES

IMPROVEMENTS ON THE FLEISCHMANN-PONS DISCOVERY

By Hal Fox, Editor

ABSTRACT

It is observed that those who have the best success with cold fusion have deviated from the original Pons-Fleischmann cell configuration in one or more ways.

Pons and Fleischmann spent several years developing their cold fusion cells before they submitted a preliminary paper [1] for peer review. Their discovery must be one of the most important scientific discoveries of the past century. It has now been shown by many scientific investigators that by closely following the original cell configuration (with proper preparation of the Pd cathode), one does indeed demonstrate that excess heat can be generated. Improvements on the cell design and operation, as originally reported [1], can provide improved or special results. Huggins et al. [2] have demonstrated considerable excess energy with a button-shaped ("fat dime") Pd cathode configuration. Yang et al. [3] have shown consistent and reproducible excess heat and tritium with daily modifications to the input voltage. Liebert's group, Liaw et al. [4] have demonstrated significant improvements using molten salts. Claytor et al. [5] have shown high tritium production by using a non-liquid gas-loading electric cell. Yamaguchi et al. [6] have produced large bursts of neutrons by special in vacuo treatment of a deuterium gas-loaded Pd wafer. These six articles are considered to be among the most important cold-fusion articles as yet written. At least two other important papers are pending.

THE NEXT EXPERIMENTAL STEPS

We do not want to detract from the tremendous efforts being made in the theory about cold fusion; however, this article pertains to experimental results. The next important step is to have other laboratories replicate the work that has been accomplished. At least one laboratory is checking the results reported by Yang et al. by trying a daily increase in voltage.

Claytor has informed us that he has replicated his own work in four different cells. Additional replication by other labs is important. Liaw and Liebert's invention (molten salts) needs to be replicated and reported. The work by Yamaguchi et al. needs also to be replicated and reported.

Note: We greatly appreciate the many scientists who have informed us of their work. We plead for a method by which the many important results can be reported faster. We know that you all want to have your discoveries published in the most important scientific journals. We know that some journals will not accept publications when the results have been previously reported. Where possible, please obtain permission from your publisher and allow us to share your successes. This rapid exchange of information on important discoveries can only help speed the day of commercialization of cold fusion. If you will send us preliminary information by the 5th of the month, we will have your results published by mid-month.

Fusion Facts will be covering a conference in October and reporting the results to you. The conference is the Anomalous Nuclear Effects in Deuterium/Solid System conference at BYU (October 22-24, 1990). Some additional important experimental findings are expected to be reported.

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[6] Eiichi Yamaguchi and Takashi Nishioka (NTT Basic Research Labs, Tokyo), "Cold Nuclear Fusion Induced by Controlled Out-Diffusion of Deuterons in Palladium", *Japanese Journal of Applied Physics, Part 2 Letters*, Vol. 29, No. 4, pages L666-L669, 26 refs.

SECONDARY NEUTRONS
By Michael Dehn, Associate Editor

The production rate of neutrons relative to tritium in cold fusion experiments has typically been reported to be only 10^{-7} to 10^{-9} to 1. In fact, the actual branching ratio may be even less, as a certain number of neutrons and other products should also be produced by secondary reactions involving either the products of the primary fusion reaction or other atoms to which these transfer their energy by scattering.

For example, in the reaction d + d --> t + p, the particles produced will have kinetic energies of 1 and 3 MeV, respectively. In such a case, the probability of a further reaction when, say, the triton collides with another deuteron, will be small but measurable (Excitation or even breakup of the struck nucleus would also be possible whenever a collision is energetic enough.)

Experimentally, it has been found that bombardment of tritium with 200 KeV deuterons can yield up to 15 neutrons per 10^6 deuterons [1]. As the d-t reaction cross-section is dominated by a (5 barn) resonance at 100 keV [2], we can therefore anticipate the number of secondary reactions which could be caused by the 1-MeV tritons in the above example to be somewhat but not tremendously greater, perhaps on the order of 1 per 3 X 10^5 fusions rather than 1 per 6-7 X 10^5.

In a similar fashion, collisions of the 3 MeV protons in the above example with deuterium should also result in a certain number of secondary reactions, although in this case neutrons would be produced only if the collision resulted in the breakup of the deuteron (possible for collision energies above 2.2 MeV). Furthermore, reaction products escaping the electrode and colliding with atoms in the solution could also produce secondary reactions.

Finally, repeated collisions of the original products with deuterium atoms would be expected to transfer a substantial portion of their 4 MeV of kinetic energy to the deuteriums, and thus allow them to initiate secondary reactions as well. Of the resulting d-d reactions, half would traditionally be expected to produce additional neutrons. It has been found that bombardment of deuterium with 1 MeV deuterons can generate 8 neutrons per 10^6 deuterons; for 200 KeV deuterons the yield was 0.3 per 10^6 and for 100 KeV deuterons it was 0.07 per 10^6 [1].

From the preceding discussion, it would thus appear likely that any cold fusion reaction could generate enough secondary reactions to account for the neutron fluxes which are typically measured. (The same is true if an alternate cold fusion reaction such as d-^{6}Li is occurring -in fact, these could be considerably more effective generators of secondary neutrons due to their higher energy yield.)

In addition, it is interesting to note that, as previously indicated, the energy spectrum of some fraction of the secondary neutrons produced could clearly show the signature of d-d fusion, regardless of the primary fusion reaction.

Lastly, the remaining fraction of the secondary neutrons would be expected to have a completely different energy distribution, and this distribution would depend on the nature of the products of the primary fusion reaction. (For instance, in the above example, 14 MeV neutrons characteristic of d-t fusion would result, suggesting that tritium was one of the products of the primary reaction.)
These predictions are, in fact, in agreement with experiments such a those of Takahashi, who reported a

neutron energy distribution with a narrow peak at 2.45 MeV characteristic of d-d fusion and a less intense but broader peak extending from 3 to 7 MeV (*Fusion Facts*, August 1990, p 5).

Suggestions for further research:

Given a sufficiently large neutron production (such as that reported by Yamaguchi and Nishioka, *Fusion Facts*, August 1990, p 2) and minimal thermalization, it may be possible to not only confirm the existence of the higher-energy neutrons, but also deduce from their energy distribution the secondary reaction responsible, and thus potentially one of the products of the cold fusion reaction.

In addition, it may be worth noting the exact width of the 2.45-MeV neutron peak, as this will increase in a predictable fashion with deuteron energy. For neutrons produced in secondary collisions, this peak should of course, be broadened by the mechanism described previously. For neutrons produced by the primary cold fusion reaction, however, a broadened distribution would imply that a mechanism such as fracto-fusion must be involved in accelerating the deuteriums to far above thermal velocities. The following table shows the neutron energy distribution which would result from different d-d collision energies [3].

deuteron energy	neutron energy (KeV)		
(KeV)	min.	mean	max.
50	2.225	2.462	2.723
100	2.146	2.474	2.852
150	2.090	2.486	2.958
200	2.045	2.498	3.052
250	2.009	2.522	3.139
300	1.978	2.524	3.220

Finally, I leave the reader to ponder the following: As a result of the chain of scattering events which would result from a fusion reaction, not only the products but a number of other atoms would acquire kinetic energies in the KeV range (rather than the sub-eV range predicted by the Boltzmann distribution). For example, if we neglect all other processes, the kinetic energy of a d-d fusion would theoretically be sufficient to impart energies in the >10 KeV range to hundreds of particles, and energies in the >1 KeV range to thousands.) In addition, excitation of some of these nuclei could be expected.

In the various cold fusion mechanisms now being considered, to what extent could this promote the cold fusion process? (After all, a self-catalytic reaction would be one of the more obvious ways to account for the burst phenomenon.)

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NEUTRON EXPOSURES TO RESEARCHERS
By Michael Dehn, Associate Editor

Given the extremely low branching ratio for neutron production in cold fusion, the radiation hazard from neutrons has until now been entirely negligible in many experiments. However, as heat outputs rise, so will neutron fluxes. Recent results such as those of Arata (in this issue), with peak neutron productions of over 10^8 n/s and total production of 10^{13} neutrons, amply demonstrate that significant neutron exposures are now possible in spite of the usual extreme "cleanness" of the reaction. Thus, researchers may wish to begin minimizing unnecessary neutron exposures before they reach such a stage in their own experiment. Although these particles are a non-ionizing form of radiation (and thus register only indirectly on some types of radiation detectors such as Geiger counters), they can still possess MeV of kinetic energy. Moreover, thermal (slow) neutrons can induce secondary nuclear reactions.

97 X 10^6 thermal neutrons/cm^2 or approximately 2 X 10^6 2.5-MeV neutrons/cm^2 are equivalent to 1 rem. Accordingly, the average yearly maximum permissible exposure is equivalent to 670 thermal neutrons/cm^2/sec or 20 2.5-MeV neutrons/cm^2/sec (1). In the latter case, the researcher's maximum allowable exposure for 1 year could be reached in only 2 minutes' exposure to a burst yielding a flux of 10^7 neutrons/cm^2/sec (at his distance from the cell).

Approximately 10 cm of water should be sufficient to reduce the neutron flux 10-fold in the case of 2.5 MeV neutrons; 10-15 cm of concrete should have the same effect. However, it is important to note that scattering requires the cell to be shielded thus on all sides - otherwise a considerable number of neutrons will simply reflect off the ceiling, etc ("sky shine").

WENDOVER MEMORIAL TO ENOLA GAY
By Gene Rutledge and Hal Fox

Wendover, Utah was selected as the site for the gathering and training of the 509th Air Force special unit because it was sparsely populated and remote, and all communications could be monitored. The 509th was created by special selection of personnel and had special privileges under the top priority code name "Silver Plate".

Fifteen B-29 bombers and all appropriate support planes and equipment were obtained and personnel trained to store, transport, maintain, and drop the atomic bomb. The bomb was not dropped on Germany because conventional warfare ended the war before the bomb was fully operational.

In the meantime, due to great military strategy by the Pacific forces, commanded by General Douglas MacArthur, the Japanese military forces had been defeated or bypassed on land. The Japanese navy had been almost entirely removed from the seas and forays of American bombers were bombing Japanese cities. Even at this stage of losses, the Japanese would not accept a defeat and were working diligently to defend their shores against the forthcoming invasion by Allied forces.

These were the events that preceded the first military use of an atomic weapon. On August 6, 1945, the 29-year old Lt. Col. Paul Tibbets dropped the first atomic bomb on Hiroshima, Japan. Contrary to popular belief, the targets were carefully selected from a group of strategic military targets. Because Japan chose to have its military factories within cities, civilian populations became subject to being targets.

Even after the intense devastation of the city of Hiroshima, the Japanese leaders chose to believe that the U.S. had only one atomic bomb. The Japanese under Hirohito would not surrender. Therefore, the 509th dropped the second atomic bomb on Nagasaki a few days later. Even after this fearful display of military might, the Japanese were slow to acknowledge defeat. The 509th was asked if they had another bomb. "Yes, at Wendover.", was the answer. They were instructed, "Get it over here, we may need it." Fortunately for another Japanese city, Japan surrendered.

The memorial services held at Wendover, Utah, August 25, 1990, dedicated a monument to the men of the 509th who, 45 years ago, trained at Wendover, Utah. This monument, placed (peculiarly) in Wendover, Nevada was dedicated August 25, 1990 by General Paul Tibbets. On the front of the monument is inscribed: "The atomic bomb is too dangerous to be loose in a lawless world ... we pray that (God) may guide us to use it in His ways and for His purposes. President Harry S. Truman, August 1945"

THE JAPANESE A-BOMB EFFORT

A famous and highly respected Japanese scientist spoke into Gene Rutledge's tape recorder (a few years ago) in an interview and said in a very emotional confession that he worked to develop a plan to build an atomic bomb to drop on "Washington, D.C. and San Francisco." This remark was met with utter astonishment.

Back in 1945 Gene Rutledge worked on the Manhattan Project in Oak Ridge, Tennessee while a teenager. The first bomb was dropped on Hiroshima, August 6, 1945 and the second on Nagasaki August 9, and Gene had the concern about whether or not it was really necessary to drop the second bomb. Many Americans who served in the Pacific told Gene that their lives were saved since an invasion of the Japanese mainland became unnecessary. Hal Fox was one whose life was thereby spared.

During the April 24-28, 1989 time period an international conference was held in Gaithersburg, Md entitled "Fifty Years of Fission." It was there that Gene interviewed Dr. Paul Kurado, a Japanese scientist. Kurado had predicted many years ago that a nuclear chain reaction may have occurred on earth millions of year ago. Kurado was ridiculed by many scientists who were convinced that the first sustained nuclear chain reaction on earth was accomplished by Enrico Fermi and associates in Chicago December 2, 1942. Kurado stated that he was not going to ridicule those claiming to have recently discovered "cold fusion" because he had been in their position years ago.

Later Kurado was shown to be correct because nuclear scientists from France did discover that a sustained nuclear chain reaction had occurred about two billion years ago in uranium ore in Gabon, Africa. (The announcement was made by the French in an Atomic Industrial Forum/American Nuclear Society meeting in Washington, D.C. in the early 1970s.)

While interviewing Kurado, Gene Rutledge suddenly asked him, "Where were you when the atomic bomb hit Hiroshima?". Kurado said, "Tokyo." Then Kurado explained that the officials in the Japanese Department of Army did not realize it was an atomic bomb but that he did.

That very afternoon, Kurado related, he was requested by the Japanese Department of Navy, with whom he had a contract, to drop everything immediately and develop a plan to build an atomic bomb. For the next eight days, Paul Kurado worked on plans for an atomic bomb. The goal, Kurado explained, was to drop atomic bombs on

"Washington, D.C. and San Francisco." Kurado also confesses a feeling of guilt for his planned actions.

The men of the 509th, we learned, have been accused of assorted crimes because of their involvement in dropping the atomic bombs on Japan. Hal Fox told several groups of the 509th, "You men saved my life. I was stationed in the Philippines and was due to ship out in the fleet of ships assembled in Leyte Gulf to invade Japan. As a member of a fixed station signal support group, we were to land in the second wave and set up communications. Typical losses in our group were 50%."

Fox believes that it was not the men of the 509th who were responsible for the death of thousands of men, women, and children but the intransigence of the military command in Japan.

The dedication of the monument to the men of the 509th marks the memories of the fearful use of nuclear energy. Located about 115 miles west of the campus of the University of Utah, this monument can also stand as a dedication to the discovery (in Utah) of cold fusion. As President Truman stated, "we pray that God may guide us to use [nuclear energy] in His ways and for His purposes." We may be fulfilling that prayer with cold fusion.

About the authors: Gene Rutledge was a teenage worker with the Manhattan Project. Currently Gene lives in Alaska and publishes energy-related newsletters and other publications. Hal Fox is the Editor of Fusion Facts.

HOOVER STRONG ON THEIR PALLADIUM MANUFACTURING

Besides supplying the palladium cathode for the initial Pons-Fleischmann experiment, we were told in Oct. '89 that our cathodes were the only ones that seemed to "work". We have no idea if this is still the case, but wish to point out that we supply the jewelry trade primarily, and that the scientists came to us, we did not solicit their business.

In hope that it may help in some way, please allow us to explain our Pd refining and manufacturing methods.

Most Pd supplied to the jewelers is alloyed with 5% ruthenium. Ours may or may not be, as requested by the customer. We process various kinds of scrap gold which may or may not contain Pd. Included is scrap from the dentists, in which Pd is used to harden caps, bridgework, etc. All of this material is processed electrolytically at least twice, and the gold is then separated onto a "Goldberg" cathode. The Pd is recovered from the residue electrolyte, and undergoes a separate double-refining process.

It is dissolved in aqua regia, precipitated with sodium chlorate, dissolved again in ammonia, and again precipitated with HCl. It is then filtered and comes off as a orange-yellow powder. It is oxidized with heat into a blue mass, to be more easily handled. From then on, it is melted in a high voltage induction furnace which may reach a temperature of 2600 degrees C.

We understand that Pd is easily contaminated, and for that reason we use a fused quartz silicate crucible, made in England, which we obtained from the Thermal American Fuzed Quartz Co. in Delaware (302-856-7741). Sometimes we add a small amount of calcium boride to the melt as an anti-oxidant depending on the observed condition of the palladium. We do not believe it contaminates the Pd in any way, as it burns right off.

The molten Pd is then poured into a rectangular mold, removed with care and cooled under tap water. After drying and annealing, it is rolled to the specifications of the customer.

While some mildly radioactive material may get past our Geiger counter (at levels too low to be recorded) all our incoming material is monitored. **We simply cannot believe that tritium contamination could continue all the way through the process described above, and feel that our firm is now getting a "bum rap" from the media.** We would appreciate a kind word or two from the scientific community.

Most respectfully submitted to "Fusion Facts" August 1990.

Davis M. Sheldon - Assayer
Hoover & Strong, Inc.
Richmond, Virginia

AN APPROXIMATE THEORETICAL BRANCHING RATIO FOR THE D-ON-D TRINT* REACTION
By Dr. Robert T. Bush

Dr. Bush's most recent paper is Cold "Fusion": The Transmission Resonance Model Fits Data On Excess Heat, Predicts Optimal "Trigger" Points, and Suggests Nuclear-Reaction Scenarios. This paper has been accepted by *Fusion Technology* for publication in the January 1991 issue. The following note from Dr. Bush is taken from this paper.

In his most recent paper, Dr. Robert T. Bush (Physics Department, Cal Poly, Pomona) shows that his model, the TRM (Transmission Resonance Model), predicts that the D-on-D reaction in electrolytic cold fusion occurs only under unusual circumstances in the palladium deuteride lattice. Thus, observable tritium production will ordinarily not be a concomitant of observable excess heat production. However, when it does occur the Bush model shows that the relative energy of approach of the D's is only about 3 meV, which is nine orders of magnitude lower than the D-on-D reaction familiar to plasma physicists! (This ultralow energy regime and its consequences based upon the TRM would also be valid for the Scaramuzzi type of experiment with titanium or palladium chips that are pressure loaded.) Bush indicates that this ultralow energy regime suggests a "polarization conjecture" according to which mutual charge distribution polarization effects between the two approaching D's in the lattice are highly significant. Based upon this polarization conjecture, which includes the idea that the D's are forced into the S-state (zero angular momentum state), Bush derives, as a minor feature of his paper, the following theoretical approximation for the branching ratio for neutron-to-triton production for the D-on-D cold fusion or **trint***, reaction:

$$BR = \frac{(r/R)^{12}}{[1-(r/R)^3]\,\{[1-(r/R)^3]^3 + 4(r/R)^3\,[1-(r/R)^3]^2 + 6\,(r/R)^6[1-(r/R)^3] + 4(r/R)^9\}}$$

(BR = Branching Ratio; r is the charge radius of the proton; and R is the "classical" charge radius of the deuteron.)

Substituting the values $r = 0.8 \times 10^{-13}$ cm and $R = 4.31 \times 10^{-13}$ cm (taken from S. DeBenedetti, *Nuclear Interactions*, John Wiley & Sons, Inc., N. Y., 1966) gives an approximate value for the branching ratio of

$BR = (1.672 \times 10^{-9}) / (1.019) == 1.64 \times 10^{-9}$,

which is in rather good agreement with recent determinations.

It is noted that this theoretical expression for the branching ratio for this ultralow energy regime should be an approximation to a more rigorous expression that would be a function of energy. Thus, as the energy of the reaction is increased, the branching ratio should eventually reach the high energy approximation of 1:1 well known to plasma physicists. As Bush points out, work must now be done to provide a rigorous basis for what he has derived in heuristic fashion from a conjecture, albeit a very appealing conjecture. While the result definitely increases the plausibility of cold fusion effects, Bush believes that the real import of this expression for the branching ratio for the D-on-D **trint** reaction might be the interest it could spur in achieving a rigorous energy-dependent value of the branching ratio.

* The **Trint** reaction, or transmission resonance-induced neutron transfer reaction is a quintessential type of reaction occurring in the Bush model that might be analogized to an ultralow energy "Oppenheimer-Phillips" reaction.

* *

H. SUMMARY OF CHINESE WORK, Courtesy of Dr. J. O'M. Bockris (Texas A & M).
The following table made by Dr. Jiujin Zhang corresponds to a recent meeting in which about 100 papers on cold fusion were presented.

COLD FUSION EVIDENCE OF CHINA

Investigators & Institution	Duration of Experiments Hours	Heat	Tritium	Neutrons	Gamma Rays	He3 or He4
Cold Fusion Group Nuclear Energy Instit. Qinghua Univ., P 1-3	21, 44, 27	___	yes	yes	___	___
ibid., P 4-6	89	___	___	yes	yes	yes
ibid., P 7-9	59			yes	yes	no
Hu Ren-Yong, et al ibid P 10-12	89	___	___	___	yes	___
Dong Shi-Yuan, et al ibid P13-15	139	___	___	yes	yes	___
Guzhen-nan, et al Dept. of Chem. Peking Univ. P 16-17	50, 360	no	___	___	___	___
Gou Oing-quan, et al The Molecular Institution, Chengdu Science & Technology Univ. P 19-22	103, 54, 27	yes	___	___	___	yes
Wang Guang-hou, et al Dept. of Physics, Nanjing Univ. P 23-25	1920	___	___	yes	yes	___
Le Yong-quan, et al The Metal Institution, Zhejiang Univ. P 28-30	290	no	___	___	no	___
Cold Fusion Group The Nuclear Institute of Shanghai P 31-33	528	___	no	no	no	___
Gad Guo-tong, et al The Dept. of Material, China Engineering Physics - Institution P 34-36	230	___	___	yes	___	___
Zhou hong-yu, et al Dept. of Chem.,Beijing Normal Univ. P 37-46	?	___	___	yes	___	___
ibid, p 47-55	?	___	___	yes	___	___
Wang Da-lum, ? P 56-61	?	___	yes	yes	___	___
Xiong Ri-heng, et al The Southwest Nuclear Physics & Chemistry Institution, P 62-63	?	___	___	yes	___	___

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I. A COLLECTION OF COLD FUSION REFERENCES

The staff of *Fusion Facts* have just assembled all of the references that have been published in *Fusion Facts* from July 1989 through June 1990. The references include all authors and their affiliations insofar as that information was known to us at the time. Laser-printed copies of the references are available from *Fusion Facts*. We are also publishing these references on desk-top computer diskettes (compatible with IBM compatible desktop computers). The cost is $20 for printed copies and $40 for a diskette version which also includes the INFOFIND search and retrieval program. A twenty-five percent discount is given to our subscribers. Ed.

READERS' HELP WANTED

We may have missed reviewing some important papers. If you have important references that we have missed, please call, fax, or write. We will provide the sender of each important positive reference with a suitable reward. We do not attempt to report on the majority of negative papers. Our policy is that scientists who professionally report negative results can only be embarrassed at a later time. We choose not to add to that embarrassment.

Dr. V.C. Noninski had carefully analyzed the data from three negative papers (where such data were made available) and has been able to show that all three measured excess enthalpy. Dr. Noninski is one of the world's most experienced scientists in calorimetry and desires to help others to understand the difficulties of cold fusion electrolytic cell calorimetry. If you have data from carefully performed calorimetry experiments on cold fusion that you would be willing to share, we will be pleased to have Dr. Noninski contact you.

* * * * * * * * * * * * *

J. UPCOMING CONFERENCES ON COLD FUSION

ANOMALOUS NUCLEAR EFFECTS IN DEUTERIUM / SOLID SYSTEM

Sponsored by EPRI, BYU, Japanese National Institute for Fusion Studies, and U.S. DoE. Conference will be held at Brigham Young Univ., Provo, UT, Oct. 22 - 24, 1990.

Interested attendees and contributors should send expressions of interest immediately by phone to:
BYU CONFS. & WORKSHOPS, NUCLEAR FUSION
154 H.C.E.B. Brigham Young University
Provo, Utah 84602
Phone 801/378-4851 (Nuclear Fusion Conf.)

This information courtesy of Dr. Nate Hoffman of the Energy Technology Engineering Center who is the Conference Secretary.

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CALL FOR PAPERS

Courtesy of Subbiah Arunachalam

The Indian Journal of Technology (the third journal -- after *J. Electroanal. Chem,* and *Nature* -- to publish an original research paper on cold fusion) invites papers. Both original research papers and critical review articles in all areas of cold fusion are solicited.

Manuscripts may be sent, in duplicate, to Editor, Indian Journal of Technology, PID, Hillside Road, New Delhi 7110012, India.

CONFERENCE PROCEEDINGS AVAILABLE

The First Annual Conference on Cold Fusion Conference Proceedings, is now available. The proceedings include the papers presented March 28-31, 1990 at the conference.
Send check for $55. Order from:

National Cold Fusion Institute
390 Wakara Way
Salt Lake City, Utah 84108

The Proceedings of the Cold Fusion Symposium of the World Hydrogen Energy Conference #8 can be ordered from:

Hawaii Natural Energy Institute
University of Hawaii
2540 Dole Street, Holmes Hall 246
Honolulu, HI 96822 USA

Make check payable to Research Corporation of the University of Hawaii. The prices is $15 for each copy of the Cold Fusion Proceedings. Price includes shipping and handling.

COMING IN THE OCTOBER ISSUE

Fusion Facts will reprint the Liaw, et al. paper describing their cold fusion experiments using molten salts. This paper was given at the recent World Hydrogen Energy Conference #8 in Hawaii.

CORRECTION: I made an error in reporting the Liaw paper (August issue of FF, pages 3 and 10). The molten salts fusion cell uses Pd as the anode and uses Al as the cathode. The LiD ionizes in the molten salts and the positive Li ion goes to the Al cathode and the negatively-charged D is conducted to the Pd anode. Hal Fox.

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The following publications have been helpful in furnishing latest fusion information:

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New Delhi 110013, India
$40 for 4 issues.

21st CENTURY SCIENCE AND TECHNOLOGY
P.O. Box 65473, Wash, D.C.
$20 for 6 issues.

FUSION TECHNOLOGY
Recently added new section on Cold Fusion
555 N. Kensington Ave.
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