FUSION facts

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Fusion Facts Now Reports on Both Cold Fusion and Other Enhanced Energy Devices.

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A. 1950's ANOMALY EXPLAINED

Were Anomalies Associated With The Excess Heat Effect Observed In The 1950's?: The Transmission Resonance Model (TRM) Answers Affirmatively.

By Dr. Robert T. Bush, Cal Poly, Pomona, CA.

In the October 1992 issue of *Fusion Facts*, an article entitled "Observations on Cold Fusion" by Dr. Harold Aspden [1] called attention to the possibility that unresolved anomalies involving the excess heat effect of cold fusion might exist in data from the 1950's involving research during that period into the specific heat contributions made by deuterium or hydrogen when palladium is gas-loaded. Aspden cited, in particular, the data by Nace and Aston [2,3] as leading candidates for just such a possibility. It was, therefore, of some interest to see what my model [4,5], the TRM, might suggest. Fig. 1 from [2], and Fig. 3, (based on a figure from [2], portray a hump in the empirical contribution of deuterium to the heat capacity of deuterium-loaded palladium.. (For all cases in this article "heat capacity" is taken to mean molar heat capacity at constant pressure.) The empirical curve resulting when deuterium is replaced by hydrogen, as shown in Fig. 2, has a very similar hump, so that the existence of this feature is not anomalistic.

What appears anomalistic, however, is the shift in the position of the peak of the hump in going from hydrogen to deuterium: Thus, this peak occurs at a temperature of 55 K for the hydrogen case (Fig.2), but undergoes a 2.5K shift to 57.5K when the hydrogen is replaced by deuterium (Fig. 1, Fig. 3). From the standpoint of 1950's physics there is no real framework to account for what was then a readily-measurable difference. It is apparently inexplicable, unless the contribution of the heat capacity curve (Fig. 3) predicted by the TRM and associated with the excess heat effect is considered. (This theoretical curve in Fig.3 was obtained by plotting the slope of the relative excess heat effect curve predicted by the TRM for deuterium in Pd versus temperature.) Thus, as seen from Fig.3, the TRM curve for the specific heat (stoichiometry of 0.48 to match the experimental stoichiometry) undergoes a decrease by about 25% in going from a temperature of 55K to 57.5K. This might very well be enough to depress the curve height at 55K sufficiently, relative to that at 57.5K, to shift the peak of the hump for the deuterium curve to the latter temperature. (The reason that a positive heat capacity associated with the excess heat effect (TRM) depresses the experimentally-determined heat capacity is that this effect is acting as a "secret", or hidden, source unknown to the experimenters. For them, then, because of the existence of this unrecognized heat source, not as much heat had to be put in externally to obtain a unit temperature rise, and the heat capacity was calculated as lower than it would otherwise have been had the contribution due to the hidden source been factored out.)

Another "anomalous" aspect that can be accounted for is that the deuterium curve (Fig. 1, Fig. 3) to the right of the peak bends back up in a shorter temperature interval than for the hydrogen case (Fig. 2). Thus, comparing Fig. 1 and Fig. 2 it can be seen that the relative minimum for the D curve above the hump occurs at about 75K (Fig. 1) whereas that for the H curve (Fig. 2) occurs at about 97K. The significant

decrease in the relative TRM heat capacity seen in Fig. 3 above 57.5K with the continuing linear decrease making it negative at around 68K appears to be able to account for the difference between the D and H cases. Note that this hypothesized bending due to the TRM specific heat contribution is consistent with the shift in the position of the peak as now shown: Thus, for the H curve (Fig. 2) the peak at 55K has a numerical height of about 2.9 and the height of the curve at 75K is about 1.7. On the other hand, for the D curve (Fig. 1) the height at 55K is about 3.0, while that at 75K is about 2.6. Thus the difference in vertical height change for the same temperature change in the two cases is [(2.9 - 1.7)- (3.0 - 2.6)] = 0.8. If now one supposed, as seems reasonable, that this difference is essentially due to a compensation provided by the TRM contribution in the D curve case, one can check the consistency of this result with the earlier vertical change associated with the peak shift from 55K to 57.5K shift: The vertical difference associated with this shift is 3.1 - 3.0 = 0.1. Then, (0.8/0.1)x 2.5K = 20K which just equals the temperature difference (75K-55K) over which the vertical height change between the two cases is established. So, we also see that the "anomalous" peak shift is consistent with the "anomaly" of the exaggerated bending up of the D curve relative to the H curve, and vice-versa.

In addition, H. Aspden [1] in his excellent *Fusion Facts* article alludes to another possible anomaly recorded in the data of Nace and Aston [2,3] around 280K to 300K. Note from Fig. 4 that the empirical D heat capacity curve begins to bend upward at a lower temperature (around 285K) than does the H curve (around 300K). Again it is seen that the theoretical TRM specific heat curve (Fig. 4) is decreasing and going to negative values near 285K which, no doubt, causes the D curve to start to bend upward at a lower temperature than for the H curve case.

Finally, then, it seems that these arguments based upon the TRM [4,5] strengthens Dr. Aspden's claims that there were "anomalies" recorded as far back as the 1950's involving the excess heat effect. Of course, at that time, there was simply no framework to provide any sort of resolution to such a difficulty. Speaking eloquently to this latter aspect directly from that era are Fig. 1 and Fig. 2 based upon references 3 and 2, respectively: Note that they both include as part of the units for the ordinate "per mole of deuterium (hydrogen)." Thus, there would have been no reason at that time to think that one could not simply scale linearly from the experimental results recorded at a lower stoichiometry (0.479 in this case) to obtain the specific heat contribution at a higher stoichiometry. Finally, it appears to have been shown that the Transmission Resonance Model has an excellent chance of helping to resolve these otherwise anomalous differences between the heat capacity contributions to palladium of deuterium and hydrogen recorded back in the 1950's.

Acknowledgements:
It is a pleasure to acknowledge discussions with Dr. Harvey Leff, Chairman of the Cal Poly, Pomona, Physics Dept., and with my colleague Dr. Robert Eagleton. In addition, the number crunching for the theoretical specific heat curves based upon my TRM algorithms was carried out by Dr. Eagleton and two Cal Poly upper division students: Derrick Holcomb and Eric Kidd.

Fig.1 Deuterium contribution to the heat capacity (molar, constant pressure) of palladium. The upper curve shows a greater temperature range.

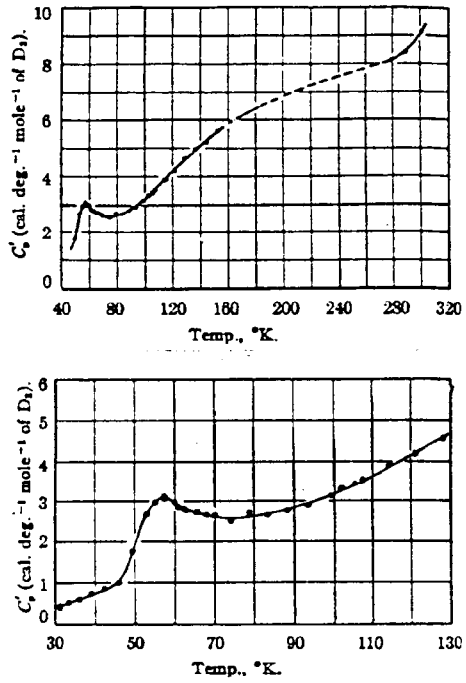


Fig. 2 Hydrogen contribution to the heat capacity (molar, constant pressure) of palladium. The upper curve shows a greater temperature range.

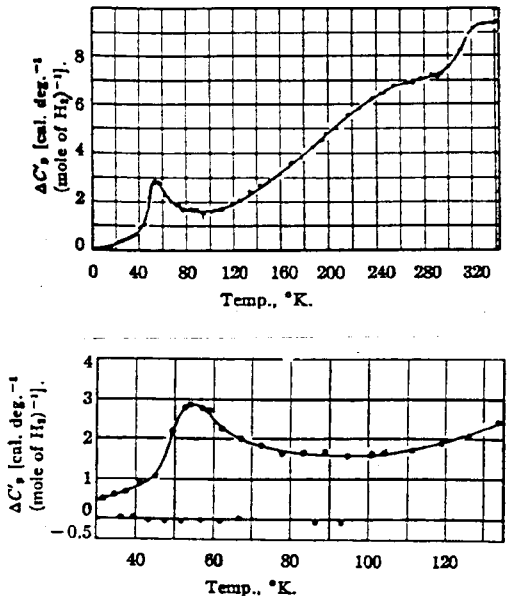


Fig. 3 TRM contribution to heat capacity (relative) (due to excess heat effect) of deuterium (open squares). Experimental heat capacity contribution of deuterium to palladium (solid squares).

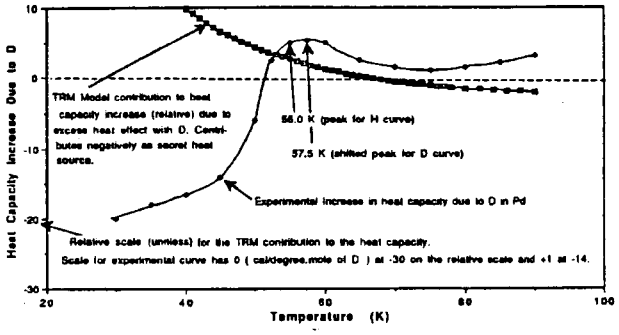
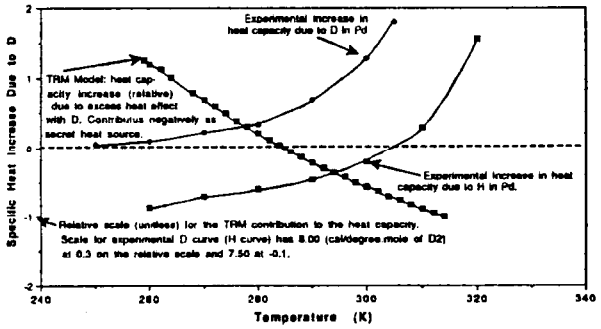


Fig.4 TRM contribution to heat capacity (relative) of deuterium (open squares). Solid squares: Experimental curves for heat capacity contribution of deuterium (upper curve), and of hydrogen (lower curve) to palladium.



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1. H. Aspden, "Observations on Cold Fusion", *Fusion Facts*, 4, October 1992, p.3.
2. D. Nace and J. Aston, "Palladium Hydride. I. The Thermodynamic Properties of Pd_2H between 273 and 345K," *J. Am. Chem. Soc.*, 79, July 1957, p. 3619.
3. D. Nace and J Aston, "Palladium Hydride. III. Thermodynamic Study of Pd_2D from 15 to 303K. Evidence for the Tetrahedral PdH_4 Structure in Palladium Hydride," *J. Am. Chem. Soc.*, 79, July 1957, p. 3627.
4. R. Bush, "Cold Fusion: The Transmission Resonance Model Fits Data on Excess Heat, Predicts Optimal Trigger Points, and Suggests Nuclear Reaction Scenarios," *Fusion Technol.*, 19, March 1991, p 313.
5. R. Bush, "A Light Water Excess Heat Reaction Suggests That 'Cold Fusion' May Be 'Alkali-Hydrogen Fusion'," *Fusion Technol.*, 22, September 1992, p. 301.

B. ANNUAL CHRISTMAS POEM

by Hal Fox
(Again this Christmas, Cold is Hot!)

The past three years are the rehearsal
For cold fusion to become commercial.
When Yamaguchi to the media sent,
His stock went up by ten percent [1].

Pons-Fleischmann's is great to try,
"Turn on" and boil the contents dry [2].
Huizenga and Morrison can pout,
New science won and they lost out [3].

Yea, it's true! No, we're not fickle,
Excess heat from water and nickel [4].
It started with Mills, spread to Cal Poly,
India and then to Japan, by golly [5]!

Karabut to Nagoya from Russia sent
Glow-discharge heat at 500 percent [6]!
Surprise from a Russian named Kaliev
Gets heat from bronze, would you believe [7]?

Everyone knows our great energy needs,
Now you might get it from electron beads.
Many electron beads in a torus,
Coulomb's barrier must be quite porous [8].

Read quickly with care, and don't dawdle,
You'll get some hints from Bush's new model [9].
Ten cold fusion scientists recently did meet,
The result, I say, was really a FEAT [10].

Cold Fusion lives! There's no revival [11].
This new science aids earth's survival.
Now the good news, you don't have to fear,
Cold fusion is real and will be next year [12].

Fusion Facts sends you loads of good cheer,
Happy Holidays, and a better New Year.

REFERENCES:

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[2] M. Fleischmann (Dept. of Chem., Univ. of Southhampton, U.K.) and S. Pons (IMRA, Valbonne, France), "Excess Enthalpy Generation in the region of the Boiling Point in Pd-type Cathodes Polarized in D_2O," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan. Reported in Fusion Facts, Nov 1992, pg 15.

[3] Douglas R.O. Morrison (CERN, Geneva, Switzerland), "Review of Cold Fusion Experiments," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan. John R. Huizenga (Univ. of Rochester, Rochester, NY), "Cold Fusion Claims," Presented at the

Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan. Reported in Fusion Facts, Nov 1992, pg 20.

[4] See Ref [1] and Robert T. Bush and Robert D. Eagleton, "Calorimetric Studies of an Electrolytic Excess Heat Effect Employing Light-Water-Based Electrolytes of Some Alkali Salts," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan. Reviewed in Fusion Facts, Nov 1992, pg 5.

[5] "Fusion Scientists of the Year," Fusion Facts, Jan 1992, pp 1-3, 9 refs. For India, Fusion Facts, July 1992, pp 5-7. For Japan, see [1].

[6] A.B. Karabut, Ya. R. Kucherov, I.B. Savvatimova (Lutch Association, Podolsk, Moscow Region), "Gamma-Spectrometry at Glow Discharge in Deuterium," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan. Reviewed in Fusion Facts, Nov 1992, pg 17.

[7] Kabir Kaliev, Aleksey Baraboshkin, A.L. Samgin, E. Golidov, A. Shalyapin, V. Andreev, & P.I. Golubnichy (Inst. of High-Temperature Electrochemistry, Ekaterinburg), "Reproduced Nuclear Reactions During Interaction of Deuterium with Oxide Tungsten Bronze," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan. Reviewed in Fusion Facts, Nov 1992, pg 18.

[8] Hal Fox, "What Happened to the Coulomb Barrier?" Fusion Facts, May 1992, pp 18-19, 6 refs.

[9] Robert T. Bush (Calif State Polytechnic Univ., Pomona), "A Light Water Excess Heat Reaction Suggests that 'Cold Fusion' May be 'Alkali-Hydrogen Fusion'," Fusion Technology, Vol 22, No 2, Sept 1992, pp 301-322, 2 figs, 61 refs. Reported in Fusion Facts, Dec 1991 & Sept 1992, pg 6.

[10] Ten U.S. cold fusion scientists have pooled money and patents pending and formed FEAT (Future Energy Applied Technology).

[11] Officers of the American Physical Society claim each increasingly large cold fusion meeting as a "revival", a "seance", or a collection of "last-gasp believers." Ha!

[12] See The Science of Cold Fusion, Proceedings of the II Annual Conference on Cold Fusion, published by Italian Physical Society, Bologna, Italy, c 1991. Also see forthcoming similar work for the III Annual Cold Fusion Conference.

C. NEWS FROM THE U.S.

CALIFORNIA - MEASURING TRITIUM

J.J. Smith (Dept. of Energy, Washington, D.C., USA) and S. Szpak and P. A. Mosie-Boss, ($N.R_3D.$ San Diego, CA., USA), "Comments On The Methodology Of Excess ^3H Determination," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

An increase in tritium concentration is considered evidence for the occurrence of nuclear event(s) when deuterium is electrochemically compressed within the *Pd* lattice (the Fleischmann-Pons effect). The evidence presented is usually measurements of tritium concentration in the electrolyte phase. Rarely have measurements of both the electrolyte phase and gaseous products of electrolysis been done. In at least one instance, tritium content in the electrode interior was included.

Measurements in electrolyte phase

The evidence for the occurrence of a nuclear event, based on analysis of the electrolyte, must show an excess of that, predicted from the isotopic separation factor. Often, the enrichment in tritium content is computed under conditions of constant electrolyte volume which, for experiments of long duration, implies continuous additions and withdrawals of electrolyte. Thus, if the initial charge, $m(O)$, is electrolyzed at constant cell current, i, for a specified period of time, r, at which time a sample is withdrawn and analyzed for tritium and D_2O is added to restore the initial volume, then neglecting the radioactive decay and loss by evaporation, the tritium mass fraction is:

$$f(t) = [m(O) - r(i)\,t]^{\xi-1}\left[\frac{f(O)}{m(O)^{\xi-1}} + \int_o^r \frac{q\,dt}{[m(O) - r(i)\,t]^{\xi}}\right]$$

The evidence for tritium production can be obtained by determining its concentration in the electrolyte phase alone but only if the isotopic factor, ξ , is either a constant of a known function of time.

Tritium in the gas phase-catalytic converter

Since the normally assumed constance of the isotopic separation factor may be disputed, it is necessary to include also the tritium content in the gaseous products. For a catalytic converter, working an efficiency $\varepsilon < 1.0$, we have:

$$f_g = f_{g\to l}\left[\epsilon + \frac{1-\epsilon}{s^2}\right]$$

where subscript $g \to l$ refers to the mass fraction found in the liquid collected in the course of catalytic conversion. Assuming perfect mixing in the catalytic converter and recognizing that the rate of reaction of D_2 with O_2 is greater than that of *DT*, we must introduce the second separation factor: $s = f_{g\to l} / f_{g\to g}$ (subscript $_{g\to g}$ denotes lost fraction).

Total mass balance

Mass balance considerations can provide the only convincing evidence that the production that of tritium has occurred, ie. that a nuclear events has ,indeed, taken place. In practice, we analyze all cell components for tritium and add its content. The net gain/loss of tritium content indicates the sought activities.

In this presentation we intend to comment on the methodology of analysis used by us and others. We will

point out difficulties in the approaches in light of our recent results.

MASSACHUSETTS -HEAT PRODUCTION

Peter L. Hagelstein (M.I.T. Research Laboratory of Electronics, Massachusetts, U.S.A.), "Possible Instabilities in Heat Production," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

Experiments on Pons-Fleischmann cells have been reported where significant temperature changes have been claimed. Little is known about the temperature dependence of excess heat production. In this paper we examine an empirical model for heat generation in which the anomalous excess heat production rate is an explicit function of temperature.

The cooling rates for rods in water exhibit a strong temperature dependence, especially when the surface temperature of the rod exceeds the boiling point. If the rate of heat production rises faster with increased temperature than the cooling rate, then a temperature instability may occur.

MASSACHUSETTS - ENHANCEMENT FACTOR

Peter L. Hagelstein (Massachusetts Institute of Technology, Research Laboratory of Electronics Cambridge, Massachusetts) "Coherence Effects: Theoretical Considerations." Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan."

AUTHOR'S ABSTRACT

A number of theories have been proposed to account for the observation of anomalies in Pons-Fleischmann experiments, some of which rely on coherence effects to obtain an enhancement in the predicted reaction rate.

Dicke superradiance is a conventional effect which exhibits an enhancement in reaction rate due to coherence. In this case, the enhancement factor may be of order N, where N is the number of coherent dipoles. The origin of the enhancement factor in this case is reviewed briefly.

The coherent neutron transfer model seeks to achieve an enhancement in reaction rate due to coherence of the Dicke type. The conditions under which such an enhancement may occur are reviewed.

Reversible transitions between degenerate states may be significantly accelerated, ultimately achieving a transition rate on the order of $| < i|H|j > |/h$. The origins of this effect is reviewed. The possibility of such acceleration in coherent neutron transfer reactions is discussed.

MASSACHUSETTS - NEUTRON TRANSFER

Peter L. Hagelstein (Massachusetts Institute of Technology, Research Laboratory of Electronics. Cambridge, Massachusetts), "Coherent And Semi-Coherent Neutron Reactions," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

During the past year and a half we have studied coherent neutron transfer reactions as a proposed explanation for the Pons-Fleischmann heat effect. A typical coherent reaction would involve the transfer of a neutron from a donor nucleus to an acceptor nucleus, with the reaction energy being taken up by the lattice.

The neutron capture onto a nucleus embedded in lattice has been analyzed quantitatively in order to determine whether significant direct transfer of energy to the lattice can occur under rather general assumptions. Our focus has been on the basic coupling mechanism; the detailed analysis of the coupling will determine the viability or nonviability of the neutron transfer model.

The relevant interaction phonon operator has been obtained, and it consists of the product of a recoil term, a mode-matching operator, and additional small terms which couple phonon operators directly with internal nuclear coordinates. These latter small terms have the potential to contribute microscopic angular momentum, but otherwise can be neglected. The recoil term can be shown not to be capable of significant coherent energy transfer comparable to a nuclear energy quantum, but is of course capable of substantial incoherent energy transfer.

The mode-matching operator has therefore drawn the focus of our attention. This operator is known in the analysis of electronic spectra in polyatomic molecules as a Duschinsky operator that mode-matching is an issue in lattices is well known, and discussions occur in the Mossbauer literature. We have so far found no previous discussion of Duschinsky operators in the context of neutron capture in the literature although few would disagree that mode-matching is an issue.

We have succeeded in calculating lattice matrix elements of the Duschinsky operator. Detailed numerical modeling of phonon generation in neutron capture in an ideal PdD crystal with a single proton substitution has been carried out, and

neutron capture line shapes have been obtained. For ground state and for thermal lattices, the energy transfer due to mode mismatch can be shown to be rather small. For a nonthermal lattice which is highly excited, anomalous phonon generation at the atomic scale is predicted.

The model has been extended to a PdD lattice containing impurities at a low level. We have found that for such a lattice the Duschinsky matrix elements may be significant for very large anomalous energy transfer in the case of a highly excited nonthermal lattice, with a corresponding anomalous capture line shape predicted. These results support the coherent neutron transfer model as an explanation for the Pons-Fleischmann effect.

CALIFORNIA - REACTOR DESIGN

Jerome Drexler (Los Altos Hills, CA, U.S.A.), "Electrodeless, Multi-Megawatt Reactor for Room-Temperature, Lithium-6/Deuterium Nuclear Reactions," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

This paper describes a reactor design to facilitate a room-temperature nuclear fusion/fission reaction to generate heat without generating unwanted neutrons, tritium, gamma rays, or radioactive products.

The room-temperature fusion/fission reaction involves the sequential triggering of billions of single molecule Li^6D "energy pellets" distributed throughout the palladium 'catalyst' that had been used to facilitate the formation of molecules of Li^6D from a solution comprising D_2O, Li^6OD with D_2 gas bubbling through it. The negative deuterium ion Is derived from the deuterium gas.

The next step is to trigger a first nuclear fusion/fission reaction at the Li^6D molecule level, according to the well-known nuclear reaction:

$$Li^6 + D \rightarrow 2\ He^4 + 22.4\ MeV$$

The energetic alpha particle generated from this nuclear reaction within the palladium "catalyst' will cause shock and vibrations in the palladium lattices, leading to compression of other Li^6D molecules and thereby triggering a second series of molecule fusion/fission reactions, leading to a third series, and so on. The absorption of the kinetic energy in the palladium will, in turn, generate a continuous flow of heat into the D2O carrier, which would be removed with a heat exchanger.

The reactor apparatus has several potential advantages over the Pons/Fleischmann electrolytic cell structure. In particular, the reactor apparatus allows scaling up the size from centimeters to kilometers, to permit multi-megawatt power levels. It also is much safer to work with since there are no electrodes or oxygen gas that could trigger the chemical reaction D + O and an explosion.

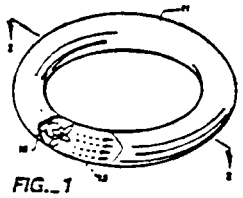
FIG._1

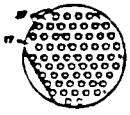
FIG._3

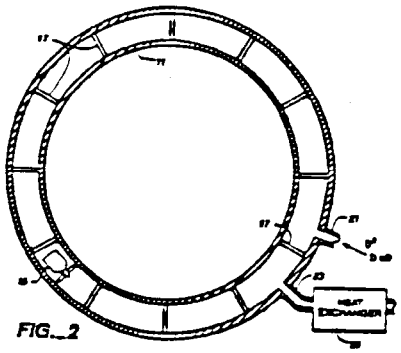
FIG._2


FIG._4

Figure 1 is a perspective view of the electrodeless 'cold fusion' reactor apparatus, showing a propeller pump for driving the ionized heavy water through a closed loop toms.

Figure 2 is a sectional view of the reactor apparatus, showing the propeller pump and a sequence of baffles, represented by *Figure 3* and *Figure 4*, which may be used as palladium or palladium alloy ion accumulators.

CALIFORNIA - CALORIMETRIC PRINCIPLES

M.H. Miles and B.F. Bush (Naval Air Warfare Center, Chem. Div., Research Dept., California., USA), "Calorimetric Principles And Problems In Electrochemical Cold Fusion Experiments," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Most of the major laboratories involved with the question of excess enthalpy in cold fusion experiments have employed isoperibolic calorimetric techniques. Thermodynamic factors that must be considered in calorimetric measurements during the electrolysis of D2O at palladium cathodes using open cells include the thermoneutral potential, the enthalpy of formation for PdD_a, the heat of evaporation for D_2O, and the enthalpy released by any possible recombination of the D_2 and O_2 gases within the cell. The use of closed cells

simplifies the calorimetric analysis but also introduces new problems such as more complex cell designs, possible failure of the recombination catalyst, the build-up of D_2 and O_2 partial pressures, and possible cell explosions.

Based on the isoperibolic calorimetric cells used at our laboratory, the major error sources arise from heat flow pathways through the top of the cell, room temperature changes, fluctuations in the cell voltage due to gas bubble effects, and changes in the liquid levels both within the cell and in the water bath. Air and other gases are always much better insulators than D_2O or H_2O liquids.

Other factors that may affect electrolytic calorimetric measurements include the size and geometric design of the cell, the magnitude of the cell current and voltage, the stirring of the electrolyte (gas evolution or mechanical), the effect of the electrolysis gas bubbles on the rate of heat transfer across the cell walls, possible temperature inversions within thermistor tubes or elsewhere, possible changes in cell constants (heat transfer coefficients), and relative roles of conduction and radiation in the heat transfer processes.

A significant problem in many isoperibolic calorimetric studies is the fact that the decrease in the electrolyte level due to electrolysis produces a significant decrease in the calorimetric cell constant when the temperature is measured in the electrolyte of the electrochemical cell. The measurement of the temperature at a secondary liquid or solid phase at the outside surface of the electrochemical cell, however, minimizes this sloping baseline problem. This secondary liquid or solid phase then simply integrates the total heat output from the electrolysis cell.

Calorimetric accuracy is improved by systems of small volume with one short dimension and by intense stirring, thus long, thin, cylindrical calorimeters are favored [1]. The significance of these calorimetric principles and problems were not obvious when several major laboratories reported their experimental results in 1989 [2,3]. A careful re-examination of earlier results is needed in terms of our present understanding of electrochemical calorimetry.

Isoperibolic calorimetric measurements at our laboratory show no significant changes in our calorimetric constants over a 2-year period. We also report excellent agreement for calibration curves obtained using solely electrolysis power with those obtained using only resistor power, thus the gas evolution process has very little effect on the rate of heat transfer across our cell walls. Numerous gas evolution measurements at our laboratory show that recombination of the D_2 and O_2 gases does not occur to any measurable extent for fully submerged palladium cathodes. These findings contradict calorimetric error sources proposed by N. Lewis et al. [2].

1. M. Fleischmann et al, *J. Electroanal. Chem.*J. Electroanal. Chem., 287,293 (1990).
2. N.S. Lewis et al., *Nature,* 340, 525 (1989)
3. D.E. Williams et al., *Nature,* 342, 375 (1989).

HAWAII - MOLTEN SALT MECHANISM

Bor Yann Liaw and Bruce E. Liebert (Hawaii Natural Energy and Dept. of Mech. Eng., Univ. of Hawaii, USA), "A Potential Shuttle Mechanism for Charging Hydrogen Species into Metals in Hydride-Containing Molten Salt Systems," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

This paper discusses a potential "shuttle mechanism" in the hydride-containing molten salts. Our previous work showed that the use of elevated temperature deuteride-containing molten salts promises great potential for charging deuterium into metals for excess heat generation. Substantial excess heat was measured occasionally but was difficult to reproduce. In light of the promising advantages such as high-grade heat, better efficiency, enhanced kinetics and possibly reduced cost from the molten salt techniques, we believe an understanding of the reaction mechanism is critical for reproducibility.

The proposed "shuttle mechanism" is based on the examination of the current-voltage relationship in various cell operating conditions. An attempt has been made to understand the reaction(s) responsible for the excess heat generation in spite of the complexity of the electrochemistry of this molten-salt system compared to heavy-water electrolysis. To identify possible electrochemical reactions during charging conditions, we examined the oxidation potentials reported in the literature. These were compared with preliminary results obtained from techniques such as cyclic voltammetry.

We found:
1. DCl formation was possibly responsible for the high-current charging reaction, enhancing the loading of deuterium in Pd.
2. DCl formation should occur at a cell potential higher than 2 V, but underpotential deposition is possible.
3. The presence of Fe and the subsequent $FeCl_2$ formation can help to stabilize the cell potential in this range.
4. To maintain DCl formation, the LiD concentration must be below a certain value, which has to be determined experimentally.
5. The DCl formation and the D^+/D^- redox reaction constitute a shuttling process that enables a high current to be maintained at high potentials without exhausting the LiD in the melt.

6. The DC1 formation and the associated high electrochemical potential may be responsible for a sustainable high loading of deuterium into Pd, which may lead to the generation of excess power and heat under the as-yet-to-be-identified favorable conditions.
7. If the above mechanism is correct, the control of the relative concentration of Li^+, Fe^{+2}, D^+, D^- and Cl^- in the melt should be crucial for the reproducibility of the excess heat phenomenon.

ILLINOIS - THIN-FILM ELECTRODES

G.H. Miley, J.U. Patel, J. Javedani (Fusion Studies Lab., University of Illinois, USA) and H. Hora and J.C. Kelly (Physics Dept., Univ. of New South Wales, Sydney, Australia) and J. Tompkins (Rockford Technology Assoc. Champaign, Illinois, USA), "Multi-Layer Thin Film Electrodes for Cold Fusion," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

It is proposed [1,2] that cold fusion reactions are initiated by "swimming electron" layers formed at interfaces between Fe, Ni or other hydrogen dissolving metals with a mismatch in Fermi levels relative to the alternate layer material, typically Ti or Pd. Indeed, promising experimental results have been reported by others using various coated electrode configurations [3,4]. Our experimental work has two objectives: development of ways to produce unique multi-layered foils preloaded with deuterium, and testing of foils with various combinations of materials using a plasma focus (PF) for added implantation of deuterium. Radiography using an X-ray film technique like that reported by Iyengar, et al. [5] is employed in these screening studies.

Thin film foils are made by electron beam evaporation from water-cooled copper crucibles onto cooled aluminum discs. Cooling of the substrates allow differences in coeffs. of thermal expansion, e.g. 12 and 8.5×10^{-6}/°C for Fe and Ti, respectively. Layer growth is controlled by a quartz crystal monitor; a deuterium atmosphere provides preloading. Typically 10-20 layers 200Å thick of Ti alternate with layers of 150Å Fe. Several other combinations of materials have also been used.

Radiographs of foils using Kodak X-O mat AR film are routinely taken prior to PF D_2 implantation; a unique exposure box is employed. Thus far several Fe-Ti foils have yielded positive radiographs at this stage. Reference foils implanted with H_2 have not produced positive exposures.

PF implantation has several distinct advantages: the PF plasma cleans the outer surface, eliminating oxide layers; higher energy ions provide good penetration: foils can be screened quickly. The U. of Illinois PF employs a 25-kJ capacitor bank, giving a $3\text{-}5 \times 10^5$ A pulse of ~40 ns using a unique axial magnetic field for stabilization. Foils are placed in a special holder with their surface at the base of the pinch plasma; ~80 pulses/foil are employed. This technique is similar to Rout, et al. [6]. This work is in progress; several PF foils have provided positive radiographs. Issues of reproducibility, correlation with foil type, and implications to the "swimming electron" theory will be presented.

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[4] Y. Arata and Y-C. Zhang, *Fusion Technology*, 22,287, 1992.
[5] P.K. Iyengar, et al., *Fusion Technology*, 18, 32, 1990.
[6] R.K. Rout, et al., *Fusion Technology*, 19, 391, 1991.

PURDUE UNIVERSITY - NEUTRINO PROBLEM

Y.E. Kim, R.A. Rice, and J.H, Yoon (Dept. of Physics, Purdue University, Indiana, USA) and M. Rabinowitz (Elec. Power Research Institute, Palo Alto, CA, USA), "High Density Fusion and the Solar Neutrino Problem," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

In a dense plasma or condensed matter, because potential energy is a significant component of the total energy, the mean kinetic energy (and effective flux velocities) of fusing nuclei is effectively reduced. Because of this condensed matter effect (CME), the higher Z nuclei thus have a larger reduction in fusion rates. Our proposed solution of the solar neutrino problem finds a smaller reduction in the reaction rates for $p(p,e+\nu_e)D$ and a correspondingly larger reduction for $^7Be(p,\gamma)^8B$. Our CME predictions are consistent with neutrino detection experiments including the recent GALLEX measurements. CME have broad ranging astrophysical implications, and may be testable in laboratory beam fusion experiments with solid targets.

MISSISSIPPI -COLD FUSION THEORY

Evan L. Ragland (Diamondhead, MS, USA), "A Physical Description of Cold Fusion," Presented at the Third

International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

Cold nuclear fusion of deuterium in an electrolysis cell with palladium electrodes is described as a comprehensive sequence of physical phenomena.

1. Electrolysis generates many more anions than are necessary to sustain ionization in the cell. The excess anions are adsorbed on the cathode surface where they create an electrical charge $\mathbf{Q_o}$ of "overvoltage" $\mathbf{E_o}$.

2. A small fraction (0.01 to 0.1%) of the adsorbed anions, which are thousands of times smaller than typical electrolysis anions and driven by MeV adsorption kinetics, penetrate several hundred lattice layers into the cathode metal. These nuclei absorb into the metal until its capacity **C** saturates.

3. Because palladium metal has the property of nucleonic conductance, or "viviance", absorbed nuclei propagate throughout the metal until the internal charge $\mathbf{Q_i}$ reaches equilibrium with the adsorbed charge $\mathbf{Q_o}$.

4. For a properly configured cathode, the density of absorbed deuterium nuclei can reach a critical level where the Coulomb force of nuclei crowds those near the cathode center to nuclear fusion.

5. The low kinetic energy of crowded fusion nuclei results in the principal nuclear reaction: $[\mathbf{D^2 + D^2 \rightarrow H^1 + T^3 + E}]$. The $[\mathbf{n + He^3}]$ reaction product is essentially repressed. Due to the short range of the energetic proton and triton in the metal, only trace product gases escape the cathode. Hence, excess heat is the predominant external evidence of the nuclear reaction.

These physical phenomena are examined in detailed theoretical arguments. It is concluded that the phenomena of cold fusion can and does occur, and that the physical explanations given in this paper reconcile the overwhelming experimental evidence supporting cold fusion.

VIRGINIA - BAND-STATE FUSION

Scott R. Chubb and Talbot A. Chubb (Research Systems, Inc. Arlington, Virginia, U.S.A.,) "Ion Band State Fusion," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Puska et al. [1] and Astaldi et al. [2] have provided experimental verification of the existence of hydrogen ion band states in adsorption studies of H and D atoms on metallic surfaces. Incident low energy electrons are used to collisionally excite ions into delocalized ion band states, in which, on the average, only a small fraction of each excited ion is located in any individual cell, and its density has the periodic order of the surface lattice. The existence of H^+ and D^+ ionic band states has importance to Cold Fusion because the quantum mechanics of ionic band states differs from the quantum mechanics of Hot Fusion.

Nuclear fusion requires wave function overlap. In Hot Fusion overlap exists during collisions and is calculated by Gamow integrals. In Cold Fusion overlap is calculated using the principle of system energy minimization. The two-electron helium problem demonstrates the method. Hylleraas [3] has shown in the two- electron helium wave function that the electron-electron repulsion "avoidance terms" are very weak. The two electrons would fuse if their interaction potential were that of two deuterons. At room temperature, real deuterons do not overlap at molecular density because of the smaller D^+ deBroglie wavelength. In a D^+ band state the many D^+-D^+ "avoidance terms" and the wave function periodicity requirement compensate for the heavier deuteron mass.

We have used the quantum mechanics of ionic band states to explain Cold Fusion [4]. The resulting theory (which we have named Lattice Induced Nuclear Chemistry [LINC]) is based on the principles used by Hylleraas [3]: an approximate solution of a well-defined many-body, quantum mechanical problem is derived by minimizing system energy, including the effects of symmetry and particle indistinguishability. The solution applies only when sufficient periodic order is present and a small concentration of ions occupy band states. When these conditions are met, D^+ ion band state wave functions overlap and nuclear reaction occurs, provided the predominant final state by-products are in ionic $^4He^{++}$ band states. Thus, through periodic order, nuclear reactions may become "distributed" throughout the solid with only infinitesimal energy release at an individual location. Additional predictions (made prior to the experimental findings of Bush et al. [5] are that in electrolytic experiments, 1) the predominant by-products should be heat and low-energy ^4He, 2) the ^4He should remain largely un-trapped within the bulk electrode and be found primarily in the surface region and outgases, and 3) there is need to satisfy a critical loading condition (of x~1 in PdD_x).

1] Puska, M.J. et al. *Phys. Rev. Lett.* 51, 1081 (1983).
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5] Bush, B.F. et al., *J. Electroanal. Chem.* 304, 271(1991).

MICHIGAN - BOSON MODEL

James T. Waber (Physics Dept., Michigan Technological University, USA), "Solid State Boson Model of Cold Fusion," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

A theoretical study based on the second proposal of Leaf Turner and embodied in the model of Chubb and Chubb, is discussed. The selection rule "Bosons In, Bosons Out" explains the relative yield of various nuclear species. The Transmission Resonance Model of Bush and Eagleton which is a solid state theorem is reviewed.

An extension of the Chubb and Chubb model to temperatures above 0° K will be briefly discussed.

WASHINGTON, D.C. - ION BEAM CHARGING

G.K. Hubler and G.P. Chambers (Naval Research Lab., Washington, DC, USA), "Search for Anomalous Nuclear Emissions by means of Ion Beam Charging of Metals," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Targets consisting of Ti, Ti alloys and compounds, Pd, Si/Si_3N_4 super lattices, YBaCuO superconductor, PZT, Ni, Ag and Au prepared as bulk specimens or in thin-film form were bombarded by 350-1000 Ev deuterium and hydrogen ions. During ion bombardment, samples were monitored with a silicon particle detector in order to detect possible charged energetic reaction products. Ions were produced using a Kaufmann hot filament ion source operating in hydrogen gas pressures in the range of 10^{-4} Torr. Base pressures for the vacuum systems were in the 10^{-7} Torr range. For bulk samples, a back scattering geometry was used to search for emission of charged particles, while for thin-film samples, a transmission geometry was used. In some cases, samples were thermally cycled during bombardment. The sensitivity of the apparatus was in the range of 10^{-22} to 10^{-23} fusions/D/s. Ion currents varied between 0.5 and 15 Ma/cm^2. Results for the various targets, as well as control experiments, and backgrounds, together with a statistical analysis, will be reported. We will also report on attempts to reproduce anomalous nuclear emissions from Ti charged by means of 350 Ev D ions produced by an electron cyclotron resonance source. Characterization of target microstructure, deuterium and impurity distribution throughout the films used in the original experiment as a consequence of ion beam loading will be discussed.

MICHIGAN - HYDROGEN EMBRITTLEMENT

W. Zhong, Y. Cai, and D. Tománek (Dept. of Physics and Astronomy, Center for Fundamental Materials Research, Michigan State University, U.S.A.), "Mechanical Stability of Pd-H Systems: A Molecular-Dynamics Study."

AUTHORS' ABSTRACT

We use the Nosé and Rahman-Parrinello molecular-dynamics formalism to study the equilibrium structure and elastic properties of bulk Pd as a function of temperature and hydrogen concentration. Introducing tensile stress as an independent variable into this formalism enables us to also study the elastic breakdown and crack formation as a function of a uniaxially applied load. The calculations are performed using a model many-body alloy Hamiltonian based on *ab initio* density-functional results for Pd-H systems. Our results indicate that the microscopic origin of "hydrogen embrittlement" is an increased *ductility* and *plasticity* in regions saturated by hydrogen, in agreement with the postulated hydrogen-enhanced local-plasticity mechanism.

TEXAS - HIGH TRITIUM PRODUCTION

Chun-Ching Chein, Dalibor Hodko, Zoran Minevski and John O'M. Bockris (Chemistry Dept., Texas A&M University, U.S.A.), "On An Electrode Producing Massive Quantities Of Tritium And Helium," *J. Electroanal. Chem.*, 338 (1992) pp. 189-212.

AUTHORS' ABSTRACT

A Pd electrode has been examined which produced a concentration of tritium in a 0.1 M LiOD solution around 10^3 times above background. Tritium production at a given potential ceased after a few days, but could be restarted be a small increase of the deuterium overpotential. Correspondingly, He^4 was found in 9-10 pieces of the Pd electrode at 2-100 times background. Addition of fresh amounts of D_2O quenched the T production which began again spontaneously after 1-2 days. If the T had come from contamination, ^3He would have been found in the electrode: it was absent. Loss of charge by the nucleus takes place when the fugacity of D in voids exceeds 10^{17} atm (Lifshitz and Pitaevskii, 1963). Sporadicity of function arises from the state of the surface, which is difficult to reproduce. The surface state controls the mechanism of D_2 evolution: only some mechanisms give a fugacity high enough to cause fusion. Only one electrode out of four examined produced T and ^4He. The surface of this electrode contained a Cu-mosaic structure, not seen on the inactive electrodes.

OHIO - FIELD THEORY MODEL

V. K. Mishra, G. Fai, and P.C. Tandy (Center for Nuclear Research, Dept. of Physics, Kent State University, Ohio) and M.R. Frank (Dept. of Physics, Hampton University, Virginia and Continuous Electron Beam Accelerator Facility, Newport News, Virginia), "Nonlocal Field Theory Model For Nuclear Matter," *Physical Review C*, Vol.46, No. 3, Sept. 1992.

AUTHORS' ABSTRACT

Nuclear matter is investigated in the relativistic Hartree approximation to a nonlocal σw model containing short distance vertex form factors to simulate an underlying QCD substructure. At the Hartree level only the nucleon momentum dependence of the distributed vertex and the resulting finite nonlocal field model is solved in Euclidean metric with simple Gaussian forms for the so-called sideways form-factor ranges at the nucleon mass scale.

UTAH - COMPARITIVE CALORIMETRY

Wilford N. Hansen (Utah State University, USA) and Michael E. Melich (Naval Postgraduate School, USA), "Some Lessons From 3 Years Of Electrochemical Calorimetry," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

In the three years since Pons and Fleischmann announced that nuclear events in an electrochemical cell could have a measurable heat signature there has been a great deal of experimental work using a variety of calorimeters. Because of the duration of the experiments (as long as several months) and the small excess power levels involved during "non-burst" events, the quality of the experimental designs and their execution are crucial to verification of the claimed result. This has led to an advance in the design and understanding of the characteristics of the calorimeters and the development of a notion of "good experimental practice".

The sources of error in the measurements of the energy fluxes in the calorimeters has been the subject of much discussion and some publication. An experimentalist attempting to select an appropriate calorimetric instrument faces difficult decisions. For example, if high sensitivity is required then closed calorimeters with extensive controls may be preferred. Such calorimeters, however, are expensive. Less expensive instruments may be available, but their behavior must be thoroughly understood and generally modelled for the results to be reliable.

This paper will present a comparative analysis of the temperature and voltage time series data from a variety of experiments which used a variety of different types of electrochemical cells in a variety of calorimeters. Using generally accepted calorimetric principles and detailed analysis aided by contemporary numerical methods, the behavior of the output data is used to assess the sensitivity and probable accuracy of the various experiments studied.

D. NEWS FROM ABROAD

BRAZIL - REACTION CROSS-SECTION

M.C.S. Figueira, E. M. Szanto, A. Szanto, M.P.Pato and M.S. Hussein (Instituto de Física, Universidade de Sao Paulo, Brazil), L. F. Canto (Instituto de Física, Universidade Federal do Rio De Janeiro, Brazil), "Role of the Breakup Process in the Hindrance of Light-Heavy-Ion Fusion Reactions," *Physical Review C*, vol 46, 3, Sept. 1992, pp 1139-1142.

AUTHORS' ABSTRACT

It has been found that the fraction of the reaction cross section diverted to complete fusion of light heavy ions is strongly correlated to the nucleon (cluster) separation energy of the participants. The presence of weakly bound nuclei hinder the fusion cross section indicating that they do not survive the collision long enough in order to contribute significantly to the fusion process. Model calculations support this picture. The ^{38}Ar compound nucleus populated by entrance channels with different mass asymmetries, i.e., ^{9}Be+^{29}Si, ^{11}B+^{27}Al, ^{12}C+^{26}Mg, and ^{19}F+^{19}F, has been investigated supporting the mentioned correlation. Consequence of this effect on the fusion cross section of exotic nuclei is discussed.

CANADA - ANODE HEATING

Ernest E. Criddle (Electrochem. Science and Technology Centre, University of Ottawa, Canada) "Implications Of Isoperibolic Electrode Calorimetry For Cold Fusion In Heavy And Ordinary Water," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

The theory of isoperibolic calorimetry can be applied equally well to electrodes operating in solution when the back of the electrode is partially isolated from the solution by potting material and a thermocouple is located next to the electrode.

Isoperibolic electrode calorimeters of 1.4 cm^2 Pd and Pt electrodes were used for the electrolysis of D_2O with separate Hg/HgO reference electrodes. Preliminary studies used simple foil electrodes potted onto a thermocouple well in polyester resin. Current reversals quickly deformed the Pd which pulled free of the polyester. Pt of 0.05mm thickness lasted little longer. Foils backed with electroplated nickel 0.5mm thick lasted almost 6 months; three corners of the square foils separated from the nickel while the fourth corner (with the lead wire) was bent back into the potting resin and remained firm.

Recent electrodes have had all four corners of the foil bent back into the potting medium. These have included Ni and Pt in polyester and Pd and Pt electrodes in silicone sealant. Observations on their lifespan will be reported.

The well known high overvoltage of oxygen evolution yields greater input watts at the anode than hydrogen evolution yields at the cathode. Our electrode calorimeters showed that anodes provide 4 times as much heating as cathodes in the electrolysis of heavy water. The anodes increased 2°C/W/cm^2 while the cathodes increased about 0.5°C/W/cm^2. The simple test tube cell with 40 ml of solution increased 10°C/W. Note the shift in units from electrode to cell.

Instrumentation is important for accuracy. An Acufex Autograph 800 data logger was used to make observations every 30 seconds and to calculate input wattage and temperature differences. The data logger averaged 10 readings over 5 minutes and printed out this average. It also printed out the minimum and maximum values observed in that period. Average values were accepted if both the minimum and maximum values were close to the average. Cell power and heater power were adjusted to keep total heating constant; in this way the cell temperature remained constant. Electrode temperatures reached each new equilibrium within 5 minutes.

This work suggests that cold fusion cells which use smaller anodes than cathodes likely experience higher anodic overvoltages and greater cell heating per watt input. This can mask small quantities of excess heat in experiments and will result in lower efficiency from working devices.

The recent news that Takahashi's excess heat was dramatically reduced when only one side of his foil was exposed to electrolysis suggests that our present design of electrode calorimeter may not observe much excess heat. More work is required.

CHINA - Pd-D ANOMALIES

Suhe Chen, Dalun Wang, Daxiao Fan, Wenjian Chen, Yijun Li and Yibei Fu (Southwest Inst. of Nuclear Physics and Chemistry, P.R. China), "The Observation Of Anomalous Phenomenon In Palladium-Deuterium System," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We employed the methods of electrochemistry and charging gas to research cold fusion. Palladium served as cathode and the anode was platinum wire material in our electrochemical experiment. The pressure and the temperature of deuterium gas loaded in the closed vessel were cycled by using liquid nitrogen.

Neutron was measured in the electrolytic experiment in July, 1991 using BF_3 counter which the detective efficiency is about 0.7%. We measured the characteristic spectrum of the counter and observed the relation of neutron count rate with electrolytic time. Neutron intensity was 10^2-10^3n/s in the experiment. Tritium was also measured using a dual-photomultiplier liquid scintillation counter in the experiment. Three explosions of the electrolytic cell happened in another electrolytic experiment. It was considered that the phenomena was not the combination of deuterium with oxygen.

X-film was mainly employed in the vessel loaded deuterium gas to study the phenomenon of cold fusion. During the experiment, the film blacked badly and the plastic deformation of palladium was observed. At present, the repeatability of the phenomena has been about 100%. The reason why the film blacked is being under study.

CHINA - RESONANCE TUNNELING

Xing-Zhong Li, De-Zhe Jin, LeeChang (Tsinghua Univ., Beijing China) and Xin-Wei Zhang, Wu-Shou Zhang (Inst. of Applied Physics and Comp. Physics, Beijing, China), "Combined Resonance Tunneling in Low Energy D-D Nuclear Reaction," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

When more evidences are confirming the anomalous nuclear phenomena in deuterium/solid system, the penetration of the Coulomb barrier at low energy is still puzzling the physicists. If there was a resonance level in low energy D+D system, the penetration might have been enhanced dramatically. However, after 20 years' searching, none of such resonance level was found in low energy D+D systems. We have found another combined resonance tunneling which may allow an appreciable penetration through the Coulomb Barrier even if there is no resonance level in D+D system.

This theoretical model is supported by the experimental data of D+D energy spectrum.

This combined resonance tunneling answers also another question: why the action in atomic scale is able to influence the reaction process in the nuclear scale. The key issue is the size of the crystal lattice.

A new matrix formalism is set up to illustrate this combined resonance tunneling in the one-dimension case using WKB approximation method. This formalism is further extended to the three-dimension case with an exact solution in the square potential well-barrier combination. Finally a numerical solution is worked out for a real D+D system to show this combined resonance effect.

Two sets of experiments are proposed. One is specially to verify this combined resonance tunneling, and the other is to drive the D+D system into this combined resonance state.

The conclusion is that the anomalous nuclear phenomenon is just a macroscopic quantum phenomenon which can be understood with usual quantum mechanics and D+D energy spectrum without invoking the assumption of virtual states or virtual particles.

CHINA - NEUTRON PRODUCTION

W.X. Liang, D.M. Xu, G.Y. Zhang, Z.L. Yao, E.Y. Wang (SW Inst. of Physics, Sichuan, China), "Neutron Measurements in a AC-discharged Tube," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

In a discharge tube consisting of a glass vacuum tube and coaxial Pd electrode, filling deuterium with pressure in the range of 10 to tens Torr, 350V AC voltage with 50Hz frequency is applied to the electrode for 20 minutes, the neutron counts recorded by long counter consisting of BF_3 counter and paraffin are still same as the background level. At this time increasing the voltage to 500V, the neutron counts are suddenly increased to the level higher than 4 times of background. Fifteen minutes later, filling little deuterium again, the neutron counts are increased to a level higher than 10 times of background.

Placing the Pd cathode and Pt anode in electrolyte consisting of a mixture of D_2O and LiOD, the pulse magnetic field up to 7 Tesla is applied around the electolyser. The measured neutron counts with and without the pulse magnetic field appear to be same.

CHINA - GLOW-DISCHARGE NEUTRONS

Hequin Long, Sihai Sun, Hongquan Liu, Renshou Xie (Inst. of Sichuan Material and Technology, China) and Xinwei Zhang (Inst. of Applied Phys. and Comp. Math., Beijing, China), "Anomalous Effects In Deuterium/Metal Systems," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

High yield of neutron emission had been measured repeatedly in the glow discharge process of the flowing of deuterium gas in a Deuterium/metal system consisting of Pt, Nb, W, Cu, Mo, Ag, or Fe with D respectively.

A layer of metal film which was deposited on the inner surface of tha glass reaction bulb in the glow discharge process and insulated from electrodes played a key action on inducing anomalous effects repeatedly. Neutrons had been measured by activation detector (^{115}In) and recoil proton neutron spectrometer. There was a continued spectrum in the energy range from 0.5 Mev to 11 Mev. The average neutron energy was 3.55 Mev. Different heights of peak appeared at (0.5-1.0)Mev, (3.0-3.5)Mev, (5.0-5.5)Mev, (8.0-8.5)Mev and (10.0-10.5)Mev. But, interestingly, the neutrons of 2.45Mev appeared in a valley of the energy spectrum.

The similar experiments were conducted many times with hydrogen or helium gas instead of deuterium but no neutron over background was detected.

CHINA - NEUTRONS PRODUCED

Huqing Long, Renshou Xie, Sihai Sun, Hongquan Liu, Jinbang Gan, Bairong Chen (Inst. of Sichuan Material and Technology, China), Xinwei Zhang and Wushou Zhang (Inst. of Applied Physics and Computational Mathematics, China), "The Anomalous Nuclear Effects Induced By The Dynamic Low Pressure Gas Discharge In A Deuterium/Palladium System," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

This paper will introduce a new type reaction glass bulb which had three electrodes. A pair of palladium electrodes (Φ2mm) were symmetrically fixed on axis of the reaction bulb (200ml), the minimum distance between electrodes was 10-15 mm, the third electrode was palladium film (thickness ~1μm) deposited on inner surface of bulb. The D/Pd atom ratio reached .05~0.8 in the experiment process. While pumping D_2 gas from the reaction bulb, the pressure of D_2 gas was sustained about 4-13Pa dynamic gas pressure, as voltage of 7-11KV(50H_z was applied between the palladium

electrodes. Stable neutron emission was detected in the observation time of 1~100 min.. The average rate of neutron emission was 13-330 n/s. The neutron energy spectrum was expected to give the two (2.0-2.5Mev and 2.5-7.0Mev) components. The production rate of high energy neutron was about 9 times of low energy neutron. The Maximum was 30 times. The production of neutron was 100% detected. Similar experiments were conducted with hydrogen gas instead of deuterium but no neutron over background was detected.

While observing neutrons, the X-ray was detected as well. The accumulative maximum dose rate reached 70 rem/h, the average energy of X-ray was about 27 Kev. but the voltage applied between the electrodes was about 11KV. If X-ray was induced by electron bremsstrahlung, the average energy of electron produces in anomalous "nuclear" events was about 40 Kev.

In addition, we observed also anomalous current pulse which average peak value was ~1A, maximum value was ~10A, and characteristic time was several ms. but the current induced by the glow discharge was less than 100mA.

Stable neutron emission, anomalous neutron energy spectrum, anomalous current pulse and 100% reproducibility, all these indicated the existence of anomalous (nuclear) effects in deuterium/palladium system.

CHINA - MEASURING LOADING RATIO

Da-Wei Mo, Li Zhang, Bo-Xian Chen, Ke-Li Wang, Shi-Yuan Dong, Ming-Yan Yao, Yu-Ying Fong, Jian Wu, Hong-Guo Huang, Jian Li, Xing-Zhong Li (Tsinghua University, Beijing, China) and Shi-Cheng Wang, Tie-Sun Kang, Nai-Zhang Huang (Inst. of High Energy Physics, Beijing, China), "Real Time Measurements Of The Energetic Charged Particles And The Loading Ratio (D/Pd)," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The loading ratio (atomic number ratio of deuterium to palladium, D/Pd) is measured in real time in parallel with the detection of energetic charged particles emitted from the deuterized palladium wire in a high pressure vessel. Three methods are used to check the loading ratio, i.e. the resistance method, the volumetric method and the weight method. The resistance method is particularly suitable for real time measurement in a high pressure vessel. It is clearly shown that the loading ratio has been over the value of 0.85 which is supposed to be the threshold of anomalous nuclear phenomenon in a deuterized palladium. Energetic charged particles are detected by a Au-Si surface barrier detector and a dE/dx detector, through which the identification of the charged particles is facilitated and the ratio of signal to noise is increased further. A special circuit for coincidence measurement is designed to catch the burst signal (i.e. more than two signals appear in a period less than 200/μsec.) The CR-39 plastic track detector is used for integration of the signals. The correlation of the loading ratio and the emission of the energetic charged particles would be addressed.

The method to enhance the loading ratio would be discussed, which may explain the failure in repetition of the "cold fusion" experiments. In fact most of these experiments are stopped when their loading ratio reached only 0.74. The pre-processing of palladium wire has a clear effect on the loading rate and the loading ratio.

CHINA - EXCESS HEAT AND ^{4}He

Q.F. Zhang, Q.Q. Gou, Z.H. Zhu, J.M. Luo (The Institute of Atomic and Molecular Science at High-Temperature and High-pressure, Chengdu Univ. of Science and Tech., China) and Y.G. Lin (The measurement Center of Chengdu University of Electron Science and Technology, Chengdu, China), "The Measurement Of ^{4}He In Ti-Cathode From Cold Fusion," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The cold fusion products ^{4}He have been measured using SIMS (Second Ionization Mass Spectroscopy) from Ti-cathode after more than 120 hours of electrolysis with remarkable phenomena of "excess heat". The analytical samples were taken from 4 different positions along the Ti-rod, both from areas immersed in the heavy water solution and above the surface. The mass number 4 species were observed in Ti-rod samples which were immersed in the heavy water solution. On the other hand, the mass number 4 species were not observed in Ti-rod samples above the surface of heavy water solution.

CHINA - THREE EXPLOSIONS

Xinwei Zhang, Wushou Shang (Inst. of Applied Physics and Comp. Math., China) and Kalun Wang, Suhw Cjen, Daxioa Fan (Inst. of Southwest Nuclear Phys. and Chem.,China), "On The Explosion In A Deuterium/Palladium System," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

There have been a number of accidental explosions in D/Pd electrolytic systems in the world, the explosion in SRI

International is a famous one. In this paper we will describe a similar one that happened in May 1991.

The electrolytic system was composed of an open cylindrical glass cell (~80ml), heavy water (~39g,), Pd tube (Φ1.67mm x 80mm, thickness 0.5mm) cathode, Pt wire anode, cooling water bath (about 450 ml water in it) and rubber plug that sealed the top of glass cell except for a blowhole (about 3mm).

Three explosions had happened. In the explosion, a rubber plug flew off about 1 meter away. The bottom of the cell was blown out, D_2O in cell was mixed with H_2O in bath. In the third explosion, the temperature of bath water raised 4°C after explosion, so about 10^4J energy had been released. But the maximum energy released from the explosion was not chemical explosion but "nuclear" explosion: PdD_x ($x \approx 1$) released ~10^4J energy in a very short time. It made the temperature of PdD_x increase and the heavy water on the surface of the Pd wire evaporate rapidly, causing the pressure in the cell to rise at once. So the rubber plug flew off and the bottom of the cell was blown out by resulting rocket action.

We consider the explosion in SRI International could be explained naturally by same mechanism.

CHINA - COLD FUSION THERMODYNAMICS

Zhong-Liang Zhang (Inst. of Chem., Academia Sinica) and Shu-I Liu (Univ. of Science and Technology of China), "Thermodynamic Theory of Cold Nuclear Fusion (C.N.F)," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The following strict criteria were derived by using the State-Field Theory of Thermodynamics (S-F, TOT) established in China in the period 1979-1991

If: $\Delta^A > \Delta^A{}_O$,

(1)

then: (C.N.F.) occurs : ... (1)

If: $\Delta^A < \Delta^A{}_O$,

(2)

then: (C.N.F.) does not occur.

Wherein : Δ^A is (the Heat Dissipation in the Discharging Process of the cell). (The Combined First and Second of Thermodynamics) of this process is:

$(\Delta Z_{T.P} = -A' - \Delta^A) / (\text{mole})$; A' = (Cell Work) < 0 ; ...(2)

$\Delta^A > 0$;

$\Delta Z_{T.P}$ = (Free Energy Increase of the Cell) ;

$\Delta^A{}_O$ = (Critical Value of Δ^A) necessary for (C.N.F.) to occur. ...(3)

A thorough, strict and complete treatment of the theory of thermodynamics related to C.N.F. is given in the Chinese text of this paper.

FRANCE - BOILING CELLS

M. Fleischmann (Dept. of Chem., Univ. of Southhampton, U.K) and S. Pons (IMRA S.A., Valbonne, France), "Excess Enthalpy Generation in the Region of the Boiling Point in Pd-type Cathodes Polarized in D_2O," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The main objective of this presentation will be the illustration by means of timelapse video recordings of excess enthalpy generation in Pd and Pd-alloy electrodes polarized in D_2O solutions. It will be shown that by using particular protocols for the experiments and appropriately scaled cells, these cells can be driven into the region of the boiling point and/or to boiling. Under these conditions the rates of evaporation / boiling are sufficiently high so that the D_2O loss from the cells can be monitored using such video recordings. These recordings in turn allow one to derive the rates of excess enthalpy generation in a simple fashion by using the enthalpy inputs and the rates and latent heats of evaporation of D_2O.

These experiments illustrate three important aspects of excess enthalpy generation in these systems: (1) that it is feasible to generate excess enthalpy in the region of the boiling point, (2) that very high specific rates of excess enthalpy generation can be achieved (> 1kW/cm^3) and that (3) the effects of changes in the experimental protocols can be monitored directly.

The temperature-time and cell potential-time records for the cells used in the video recordings and of related cells will be discussed. We will also comment on strategies for the determination of the heat transfer coefficients for cells to be used at lower temperatures. Finally, we will consider the pointers for further research provided by the video recordings of these experiments.

ITALY - MEASURING TRITIUM

A. Alessio, M. Corradi, F. Croce, F. Ferrarotto, S. Improta, N. Iucci, V. Milone, B. Stell, G. Villoresi (INFN Roma and Dipart. di Fisica e Chemica, Universitá La Sapienza, Rome, Italy) and F. Celani, A. Spallone (INFN Frascati, Roma, Italy) and S. Forunati, M. Tului (C.S.M., Roma, Italy), "The FERMI Aparatus and a Measurement of Tritium Production in an Electrolytic Experiment," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

FERMI is BF_3-^3He apparatus with detection efficiency for moderated neutron, pulse shape acquisition and good sensitivity to neutron bursts; it also performs a good statistical reconstruction of the average neutron energy. Gamma rays are detected by a complementary low background NaI detector. The neutron background measured by the apparatus in the Gran Sasso INFN underground laboratory is a tenth of a Hertz. A few different experiments have been performed with the same detector.

A D_2O-$LiOD$ electrolysis with Pd electrode had been realized with emphasis on the cleanliness of all components. D_2 and O_2 produced gases were recombined using a room temperature catalyst and the resulting water was monitored twice a day for tritium content; the same was done for samples of the electrolyte solution.

Loading the Pd up to the alpha and beta phases with variable currents, an elongation of 150μm was observed in the first few days accompanied by a 60% - 100% tritium excess detected in the recombined water. The measured neutron rate in the same period was consistent with the natural background.

ITALY - NEUTRONS PRODUCED

M. Corradi, F. Ferrarotto, M. Giannini, V. Milone, B. Stella, L. Storelli (INFN Roma and Dipar. di Fisica e di Ingegneria. Nucleare, Universita "La Sapienza", Roma, Italy) and F. Celani, A. Spallone (INFN Frascati, Roma, Italy), "Evidence for Stimulated Emission of Neutrons from Deuterated Palladium," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Metallic Palladium (8 mm thick) deuterated at the beta phase has been irradiated with partly moderated Am/Be neutrons and the resulting neutron flux has been measured by the FERMI apparatus, a high efficiency detector for moderated neutrons, performing pulse shape acquisition. Once subtracted the vessel + gaseous deuterium effect, measured in "blank" runs, an excess of 6 ± 1% neutrons on the total rate has been detected.

The statistically reconstructed energy of the neutrons emitted by the radiated sample averages 0.1-0.4 KeV; its rate gives a very high cross section, corresponding to two outgoing neutrons for every neutron impinging on the Pd sample. Similar measurements with Cadmium absorber around the Am/Be source gave lower effects.

The underlying process can be interpreted as recoil d-d interactions and the excess (respect to the incoherent deuterium effect), as predominantly due to slow incident neutrons, indicates a crucial role played by the Palladium lattice in catalyzing the deuterium-deuterium fusion. The experiment is being repeated for confirmation.

ITALY - TRANSPORT MODEL

A. De Ninno and V. Violante (ENEA Frascati, Roma, Italy), "'Quasi-Plasma' Transport Model In Deuterium Overloaded Palladium Cathodes," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The Pd-D system has been described assuming a two-population model. A "quasi-plasma" delocalized boson gas picture has been used for the deuterons exceeding the stoichiometric ratio in Pd-D compounds.

A mathematical model supported by a numerical computer code with distributed parameters has been developed in order to describe the evolution of the deuteron concentration profile inside a Pd cathode under pulsed electrolysis. Several boundary conditions have been taken into account. A strong correlation has been found between the model system evolution and the experimental data.

ITALY - CRYOGENIC ^4He DETECTION

L. Bertalot, F. De Marco, A. De Ninno, A. La Barbera, F. Scaramuzzi, V. Violante, P. Zeppa (ENEA, Frascati, Italy), "Study Of The Deuterium Charging In Palladium By The Electrolysis Of Heavy Water: Search For Heat Excess And Nuclear Ashes," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

An experiment on the electrolysis of heavy water with palladium cathode and anode is in progress. A measurement of the thermal balance of the phenomenon has been performed with a calorimeter inspired to the type used by the Osaka Group (Prof. Takahashi). The correct behavior of the calorimeter has been proved, and the first measurements aimed to put in evidence the production of excess heat have been started, and are under way, with positive results. Particular care has been dedicated to studying the mechanism of deuterium charging in the metal lattice, and to identifying the parameters controlling the process. The results of this experiment will be reported.

In the hypothesis that the heat excess is of nuclear origin, the most likely "ash" to be expected is ^4He (that has already been detected in a previous experiment: see the Proceedings of the Como Conference, 1991, under Miles). A system aimed to the detection of ^4He has been devised, based on the separation of the different gases evolving from the electrolytic cell with cryogenic techniques. A prototype of this apparatus is under construction and the results of the first tests will be reported.

ITALY - 2.5 MeV NEUTRONS

E. Botta, T. Bressani, D. Calvo, A. Feliciello, P. Gianotti, C. Lamberti, M. Agnello, F. Iazzi, B. Minetti, and A. Zecchina (Univ. di Torino, Italy), "Measurement of 2.5 MeV Neutron Emission from Ti/D and Pd/D Systems," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Following our previous observation of 2.5 MeV neutron emission from metallic Ti shavings loaded with gaseous D_2 and submitted to temperature cycles [1], we have performed a new set of measurements on neutron emission from Ti and Pd loaded with gaseous D_2, using a cell of improved design [2]. Neutrons were detected by a time-of-flight spectrometer using the double scattering technique [3]. We used 20g of high purity Ti sponge and 54g of metallic Pd respectively. The D_2 loadings, temperature variations and pressures were such to allow a crossing through the β-δ phase transition for Ti and α-β for Pd. For each sample we performed analogous measurements with gaseous H_2 filling for background subtraction. Fig. 1a shows the spectrum of neutrons emitted from the Ti/D system after background subtraction and Fig. 1b that for the Pd/D system. The first one shows a signal with a statistical significance of ~5σ in the channel corresponding to 2.5 MeV neutrons, with a shoulder extending up to 6 MeV. The corresponding neutron flux is 0.11 ± 0.03 neutrons g^{-1} s^{-1}. The spectrum relative to the Pd/D system exhibits a not very significant enhancement at 2.5 MeV (2σ), that would correspond to an emission of 0.02 ± 0.01 neutrons g^{-1} s^{-1}. It appears that the neutron emission is distributed along the full duration of the runs (13933 minutes for Ti and 2820 minutes for Pd) and not concentrated in a few bursts. The 2.5 MeV neutron flux measured in this experiment is one order of magnitude lower than that measured in a similar previous experiment with metallic Ti [1]. Ti sponge has certainly a surface/volume ratio very much larger than metallic Ti shavings. These results may indicate that the 2.5 MeV neutron emission from Ti is essentially a bulk phenomenon, in accordance with the superradiant coherent model [4].

1) T. Bressani et al., *Nuovo Cimento* 104A (1991), 1413.
2) M. Agnello et al. in "The Science of Cold Fusion", Proc ACCF2 (SIF, 1992), p.249.
3) G.C. Bonazzola et al., *Nucl. Instr. Meth.*, A299 (1990), 25.
4) T. Bressani, E. Del Giudice and G. Preparata, *Il Nuovo Cimento* 101A (1989), 845

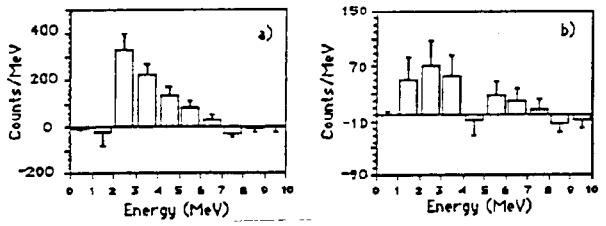


Fig.1a) Spectrum of neutrons emitted from Ti/D

Fig.1b) Spectrum of neutrons emitted from Pd/D

ITALY - PULSED ELECTROLYSIS

Francesco Celani, Antonio Spallone, Paolo Tripodi, Anna Nuvoli (I.N.F.N. Lab. Naz. Frascati Nia E. Fermi, Rome, Italy) "Measurements Of Excess Heat And Tritium During Self-biased Pulsed Electrolysis Of Pd-D_2O, "Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Following the experiments by A. Takahashi of excess heat during pulsed mode electrolysis of Pd plate (from Tanaka Kikinzoku Kogyo K.K.) in 0.3M/1 of $LiOD/D_2O$ we built a high sensitivity (0.5 W) and large dynamic range (up to 3 KW) flow calorimeter. We acquire 5 temperatures: T_{in} and T_{out} of cooler (with twin thermometers), T cell, T ambient, T input of remote water cooler. The cell is partially closed (with unidirectional external evaporation) in order to evaluate both D/Pd loading ratio and electrolysis efficiency. The cell is self-biased because we introduced a diode between power supply and cell in order to decouple it during the H to L voltage transition; this approach seems to reduce even the loading time of deuterium. Calibration and blanks are performed by electrical heater and Au-substitute plate (both

H_2O and D_2O experiments). During the first experiments we get an excess heat, of the order of 10% with LiOD and Pd. The full understanding of this experiment was reduced because of corrosion problems. Tritium is measured and neutrons are monitored. A second improved experiment, with promising preliminary results, is running.

ITALY - THEORY

Giuliano Preparata (INFN - Laboratoi Nazionali di Frascati and Dipartimemo di Fisica, Universitá di Milano, Italy), "Theory Of Cold Fusion In Deuterated Palladium," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

The many "miracles" occurring in deuterated during (but not only) Cold Fusion experiments are analyzed in the light of the new theoretical developments on Quantum electro-dynamical coherent processes in condensed matter.

A comprehensive, predictive, successful and coherent theory emerges whose highlights will be discussed.

JAPAN - HELIUM RATIOS

G. Adachi and H. Sakaguchi (Dept. of Applied Chemistry, Faculty of Engineering, Osaka University, Japan) and K. Nagao (Inst. for Study of the Earth's Interior, Okayama University, Misaso, Japan), "^{3}He and ^{4}He From D_2 Absorbed In $LaNi_5$." *Journal of Alloys and Compounds,* 181 (1992) pp 469-476 JAL 8083.

AUTHORS' ABSTRACT

Helium isotopes from D_2 gas absorbed by $LaNi_5$ were analyzed with a noble gas mass spectrometer to search for evidence of cold fusion. The ratio of ^{3}He to ^{4}He in the sample gas obtained after repeated temperature cycling for about 30 days was different from that in the sample gas before treatment. Increases in ^{3}He were observed in two experiments using different reaction vessels, indication that a nuclear reaction may have occurred.

JAPAN - PLASMA-SPRAYED CATHODE

Yoshiaki Arata and Yue-Chang Zhang (Osaka University, Osaka, Japan), "Reproducible "Cold" Fusion Reaction Using A Complex Cathode." Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

A new complex cathode was developed, consisting of a nickel (or palladium) rod with a palladium layer applied by plasma spraying. The actual surface area of the complex cathode was incommensurably larger than that of an ordinary cathode surface, and the sprayed palladium layer has numerous micro-defects such as cracks, porosity, boundary layer, lattice defects, dislocations, uneven surface, localized strain, etc. It seems that the actual large surface area and micro-defects are a necessary condition for "cold" fusion. In this experiment, high reproducibility of a "cold" fusion reaction is confirmed by using this cathode. The palladium layer activates the surface functions of the deuterated cathode, and reliable evidence was obtained that a new type of heat generation occurred in the complex cathode. For example, when the deuterated complex cathode is withdrawn from the electrolytic cell into the air, a strong heat is discharged and its inner temperature elevated by 361°C, with energy of 20kJ. However, a similar palladium cathode without a sprayed palladium layer did not discharge heat.

JAPAN - NEGATIVE RESULTS

E. Choi, H. Ejiri, and H. Ohsumi (Dept. Phys. Osaka Univ., Japan), "Limit on Fast Neutrons from DD Fusion in Deuterized Pd by Means of Ge Detectors," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Search for fast neutrons from the electrochemically loaded Pd-d system at room temperature was made by means of a Ge detector. A low-background highresolution Ge detector surrounded by neutron scatterers is shown to be used as a low-background neutron counter for fast (1~5 MeV) neutrons. Here the neutron flux is obtained by measuring yields of the γ-rays following inelastic scattering of fast neutrons from nuclei in the scatterer. Here the 7-rays have discrete energies. Thus the Ge detector with a high energy resolution is very sensitive to such γ-rays following fast neutrons and is insensitive to other backgrounds.

The 2.45 MeV fast neutrons from the dd fusion are inelastically scattered. The electrolytic cell was placed in front of the Ge detector. The Fe plate, as the fast neuron scatterer, was inserted between the detector and front of the cell. Another Fe plate was also placed at the backside of the cell. The ^{65}Cu and ^{63}Cu in the OFHC (oxygen free high conductive copper) shield and Ge isotopes in the detector itself are also used as the scatterer of the fast neutrons. The minimum neutron flux to be detected is 9.6×10^{-3} neutrons per second for one week measurement.

Measurement was made for 471 hours by using Pd(59.04g) and Pt electrodes in the electrolysis of D_2O. The Pd electrode was set between two platinum anodes with 10mm spacing. The electrolysis was operated in a constant current mode at 0.7A. The applied electric voltage was about 8V. We measured the weight of the Pd plate as a function of time during the electrolysis. The weight increases gradually and finally saturates at the fixed weight. The increase of the weight gives the total number of the deuterium atoms in the palladium plate.

We searched for the 847 KeV γ-ray following the first 2^+ state in ^{56}Fe excited by the inelastic scattering of the neutrons from in the iron scatterers. The observed spectrum shows no statistically significant excess of the γ-rays above background. We have obtained an upper limit on the fusion rate of $1.6\text{-}10^{-24}$ fusions / [(*dd* pair) sec]. This is smaller than reported before.

JAPAN - VOLMER-TAFEL MECHANISM
Courtesy of Samuel P. Faile

M. Enyo and P. C. Biswas (Catalysis Research Center, Hokkaido University, Sapporo, Japan), "Hydrogen Absorption In Palladium Electrodes In Alkaline Solutions," *J. Electroanal. Chem.*, 335 (1992) 309-319.

AUTHORS' ABSTRACT

The entry of hydrogen into a palladium electrode in alkaline solutions was investigated. It is shown, from analysis of the overpotential components observed in transient polarization measurements, that the hydrogen electrode reaction on palladium obeys the Volmer-Tafel mechanism, similar to that in acidic solutions studied earlier. Hydrogen pressures equivalent to hydrogen overpotentials are evaluated. They increase with the overpotential but the dependence is much less than that calculated by applying a Nernst type equation to the total overpotential; this is also similar to the behavior observed in acidic solution. The equivalent hydrogen pressure is practically independent of the concentration of alkali but slightly dependent on the kind of alkali, being highest in KOH solution.

JAPAN - CREEPING NEUTRONS

Masatoshi Fujii, Masami Chiba, Kenji Fukushima, Motomi Katada, Tachishige Hirose, Kenichi Kubo, Hiroaki Miura, Shinya Miyamoto, Hiromichi Nakahara, Yuki Nakamitsu, Tsutomu Seimiya, Toshiaki Shirakawa, Keisuke Sueki, Hideyuki Toriumi, Torahiko Uehara and Toshihiro Watanabe (Dept. of Chem. and Phys., Faculty of Science, Tokyo Metropolitan University, Japan), "Measurement of Neutrons in Electrolysis at Low Temperature Range," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We observed three neutron trains continuing 2 or 3h as the excess flux during an electrolysis of 1878h. A palladium cathode was used in deuterated alcoholic electrolyte at low temperature range. Those were 22 counts/2h, 27 counts/3h and 27 counts/3h in the average background counts of 4/h. We could not find any excess in the other time intervals between 28.6ms and 1878h. Those production rates of the 22 and 27 counts were $6.3x10^{-24}$/d-d pairs and $4.5x10^{-24}$/d-d pairs during 2 and 3h, respectively. The confidence levels of 22/2h and 27/3h estimated from the statistics were 88% and 59%, respectively. For the total of the three trains, the confidence level became 98%. The neutron emission might be due to a creep effect in the palladium cathode because the time constant of 2 or 3h is known as a typical creeping time constant in a metal. If their were noises caused by unknown sources, the 97.7% upper limit of the production rate was set to be $1.2x10^{-25}$/d-d pairs. The experiment was done in the Low Background Facility at Nokogiri Mt. of The Cosmic-Ray Research Institute, University of Tokyo.

JAPAN - PULSED NEUTRONS

Masanori Fujiwara and Koichi Sakuta (Electrotechnical Lab., Tsukuba-shi, Ibara-ki, Japan), "Statistically Significant Increase in Neutron Counts for Palladium Plate Filled with Deuterons by Electrolysis," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACTS

Statistically significant increase in neutron counts was observed in relation to the difference in the absorbed deuteron amount in Pd plate during an alternating electrolysis of D_2O with Pd/Pt electrodes.

Two ^3He proportional counter tubes were used for the neutron detector. All the electrolytical devices, ^3He counters and water tanks for neutron thermalization were covered with cadmium plate and set in a pile of water tanks, measured 1.5w x 1.2d x 2.3h (m), to shield background neutrons. The efficiency of the neutron measurement was about 1.6%.

For the noise discrimination in the neutron measurement, the wave form data of ^3He amplifier output was analyzed using wave form analysis. Neutron signals were specified by the pulse height analysis.

The size of the Pd plate of 99.9% purity was 50 x 12 x 0.1 (mm), which was surrounded by 4 turns of Pt wire of 0.5

mm diameter. D_2O solution of 0.1 mol/l LiOD was used as the electrolyte. One cycle of the electrolysis consisted of 4 different stages, 2 hours each, totaling 8 hours. Each stage was classified by the deuteron state in the Pd plate, that is, Pd was (1) being charged, (2) filled, (3) being discharged and (4) emptied with deuterons. Each stage was a constant current electrolysis with different current. It was (1) 264 mA (22 mA/cm^2), Pd negative, (2) 0 mA, (3) 104 mA (8.7 mA/cm^2), Pd positive and (4) 0 mA, respectively. The D/Pd ratio in the stage (2) was estimated to be 0.77.

Forty-six cycles (368 hours) of experiments were executed using a single Pd sample. The average neutron count rate measured in each stage was (1) 52.0, (2) 52.9, (3) 49.5 and (4) 48.8 (counts/2 hours), respectively. Following the standard statistical procedure, the difference of the averages was tested using t-distribution. It indicates that the difference between the stages (2) and (4) is highly significant with 99% reliability. In other words, the measured neutron count rate in the filled state (2) is greater than that in the emptied state (4) with 99% reliability. The confidence interval of the neutron count rate difference is estimated to be 0.8 ~ 3.2 counts/hour with 90% reliability. This corresponds to 0.8 ~ 3.0 fusions/deuteron pair/sec.

For further confirmation, the signals outside the neutron region of the pulse height analysis were tested statistically. No significant difference was found among the 4 stages. Consequently, it is confirmed that the increase of the signal in stage (2) was due to neutrons, because the pulse height spectrum as well as the wave shape corresponds to the characteristics of the neutron signal.

In order to consider the influence of the atmospheric pressure on the background neutron count rate, the average atmospheric pressure was compared for each stage. No difference requiring further consideration was recognized.

The reproducibility is not yet confirmed. The experiment using second sample with the same procedure is under way. No significant difference among the 4 stages has been found in 33 cycles (264 hours) up to the present. We are planning further experiments for checking and confirming the reliability of our current procedures.

JAPAN - SONO-FUSION

Kenji Fukushima (Dept. of Physics, Tokyo Metropolitan Univ., Japan), "A New Mechanism for Cold Fusion -- Sono-Fusion," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

Recently a phenomena named sonoluminescence (SL), such that cavities created when ultrasound passes through a liquid luminesce at their adiabatic contraction phase, has attracted the attention of researchers in a variety of fields of science and technology.

One of the most characteristic features of the SL is the surprising concentration of energy as pointed out by Putterman et al. [1] Namely, the energy of ultrasound is roughly of order of 10^{-11} *Ev* per atom, that of the luminescence, on the other hand, being several *Ev* per atom; the ten to the eleventh power times enhancement.

A.J. Walton et al. claimed in their review work [2] that in the ambient condition an air-filled transient bubble in water with equilibrium radius 60 μm created by ultrasound of pressure amplitude 4 *bar* and frequency 15*kHz* reaches the maximum temperature 3.7 x 10^6 *K* and pressure 7.8 x 10^8 *bar* when its radius is 0.6 μm.

Now we arrived at a new mechanism for cold fusion to be named sono-fusion. Let us simply replace air by D_2 gas in the above example. The *d* - *d* fusion rate in the extreme conditions may be calculated as:

$$\lambda = \left(\frac{\tau}{T}\right)\left(\frac{N_e}{N}\right)^2 N \rho v \sigma(E) = 1.2 \times 10^6 \times \left(\frac{\tau}{T}\right)\left(\frac{N_e}{N}\right)^2 \text{sec}^{-1} ,$$

where τ is the duration of the extreme conditions, T being the period of ultrasound. N and N_e are, respectively, the number of D_2 in an original bubble and that remaining in the minimum bubble without diffusing into liquid, ρ being N divided by the minimum volume of the bubble. v and $\sigma(E)$ are, respectively, the velocity and cross section for *d* - *d* fusion at the extreme conditions. Here it is assumed that a single transient bubble is created and collapses in each period of ultrasound.

Usually the factor N_e/N is set to unity, because the velocity of the bubble wall is greater than that of diffusion and we have to numerically solve, however, the equation of motion to determine the duration τ. We shall do it taking into account relevant effects such as the compressibility of a liquid, mass diffusion, heat transfer, phase transition of D_2 gas etc. and qualitatively fix the fusion rate.

On deriving the expression for the fusion rate, we postulated incoherent collisions of *d*. The average distance between *d*'s is in fact 0.3 x $10^{-10}m$ in the minimum bubble, so that should be taken account of the many-body correlation effect, which seems to considerably improve the fusion rate.

1] B.P. Barber and S.J. Putterman, *Nature* 352, 318(1991).
2] A.J. Walton and G.T. Reynolds, *Advances in Physics* 33, 595(1984).

JAPAN - HEAT VS. LOADING RATIO

Norifumi Hasegawa, Keiji Kunimatsu (IMRA Japan Co.,Ltd. Sapporo, Japan), Tamio Ohi, Tosihisa Terasawa (Aisin Material R&D Co.,Ltd. Kariya, Japan), "Observation Of Excess Heat During Electrolysis Of 1M LiOD In A Fuel Cell Type Closed Cell," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We have carried out several experiments to examine the anomalous excess heat generation in the electrolysis 1M LiOD with a Pd cathode, using a gas diffusion electrode as an anode. Pd rod(ϕ4 x 18.5mm) was used as cathode, and we carried on electrolysis for more than 2 months.

At first Ni rod (ϕ4 x 18.5mm) was used as a cathode to measure relation between input energy and temperature rise inside the cathode. The relation served as a calibration curve. After measurement of calibration the cathode was changed to a Pd rod. Temperature rise in Pd electrode versus input energy was compared with the calibration curve (Fig-1). This result shows that excess heat generation occurred (maximum generation of 35% with respect to input to the cell). We observed also a relation between excess heat generation and deuterium loading ratio (Fig-2). This result shows that when the loading ratio becomes about 0.85, excess heat generation is observed. When loading ratio reached 0.88, excess heat generation reached 35%. The excess heat generation was not observed in the electrolysis of 1 M $LiOH/H_2O$.

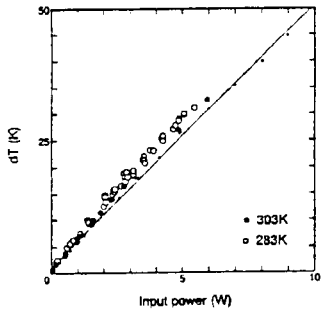


Fig-1 dT vs.input power on Pd in 1M LiOD at 283K,303K

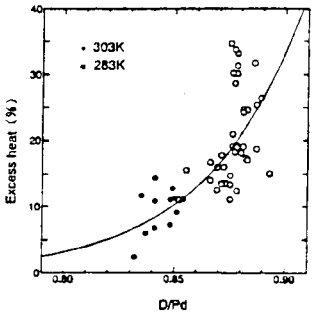


Fig-2 Excess heat vs.D/Pd on Pd in 1M LiOD at 283K,303K

JAPAN - NO CLEAR HEAT BURST

Shigeru Isagawa, Yukio Kanda and Takenori Suzuki (National Lab. for High Energy Physics, Ibaraki-ken, Japan), "Search For Excess Heat, Neutron Emission and Tritium Yield From Electrochemically Charged Palladium In D_2O," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Aiming to reproduce the claimed excess heat and neutron emission from electrochemical cell [1], power balance and radiation emission measurements have been continuously carried out [2] for more than 3 years on several sets of open type cells consisting of Pd cathodes, Pt anodes and D_2O/0.1M LiOD electrolytes. Two types of glass cells have been used; a) water-cooled cells with a cooling water jacket and b) thermally insulated dewar type cells immersed in constant temperature water baths. A variety of Pd rods have been tested as the cathode. They were as received, annealed in vacuo or remelt in Al_2O_3 crucibles with a UHV induction furnace. Electrolysis has normally been done in constant current mode, although the current was sometimes modulated in various manners. For a) type cells, relatively larger samples were used with a current density up to 1050 mA/cm^2. Power balance was checked by comparing the cell temperature difference and the flow rate of water in a cooling channel. For b) type cells, relatively smaller samples were used with a current density up to 840 mA/cm^2. Excess heat was monitored only by use of the calibration curve.

For neutron emission measurement a single or double rem counter system was used, in which dose meters of BF_3 and/or He_3 type were placed adjacent to the electrolysis cells. Tritium concentration in the cells before, during and after electrolysis were intermittently measured with a liquid scintillation counter by an external standard method [2]. In order to check the hydrogen contamination during long-run electrolysis, a quantitative analysis of H/D ratio was also made by infrared spectrophotometry [3]. The Li concentration was measured by ion chromatography technique. Although many indications of excess heat have been observed so far, almost all of them except one has been excluded as a ghost by further experimental reexamination. They were caused by: 1) freezing of electrolyte; 2) change of calibration curve with time due to unexpected escape of Li from the cells; 3) measurements errors in temperature difference; 4) calibration change of flow rate of the cooling water. Until now we have never observed a clear-cut heat burst as shown in the references [1]. One example of abnormal power balance observed in a) type cells has not been ruled out, however, even after re-calibration of the flow rate. Neutron and tritium shown no anomalies in this case. This phenomenon cannot be repeated any more under similar experimental conditions.

Neutron emission, on the other hand, as a very rare case showed an abnormal increase in one of the series of b) type experiments. Increase of neutron emission, about 3.5σ above the background level lasted for 9 hours on the 20th day after starting the electrolysis. Four cells were installed in the bath, one of which just showed a spontaneous increase in current coincidentally. Another rem counter located 3m apart showed a small increase of counting rate, but in the limit of statistical error. No observation of solar neutrons associated with the large flare has been reported on this date. If this

cell is assumed as a source, emission rate subtracting the background is equivalent to about 23±7 neutrons s^{-1}. This phenomenon also happened only once without accompanying any heat excess or abnormal increase of tritium. It is reported that 0.9 D per one Pd is the critical threshold value to get the cold fusion phenomena. This being the case, the sample preparation may be one of the most important factors for reproducing the phenomenon. Even after taking great care against hydrogen intake, parallel experiments proved that the D_2O or the electrolyte could be contaminated with unexpected amounts of hydrogen from air. This fact could account for the lack of repeatability of above mentioned experimental results. Improvement of the cell design is now being continued in this aspect. Addition of the second material like Ag is also being considered.

[1] M. Fleischmann, S. Pons and M. Hawkins, *J. Electroanal. Chem.*, 261, (1989) 301; 263 (1989) 187.
[2] S. Isagawa, Y. Kanda, K. Kondo, M. Miyajima, S. Sasaki, T. Suzuki and T. Yukawa, *KEK Report* 89-15, October (1989).
[3] H.S. Bosch, G.A. Wurden, J. Gernhardt, F. Karger and J. Perchermeier, *J. Fusion Energy,* 9 (1989) 165.

JAPAN - ALUMINUM FUSION

Kohji Kamada (Nat. Inst. for Fusion Science Furo-cho, Nagoya, Japan), "Electron Impact H-H and D-D Fusions in Molecules Embedded in Al," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

The experiment reported here contains two new findings: The first is the observation of H-H fusion reaction, which has been elaborated theoretically by Bethe et al. [1], with different mechanism from that proposed here. The second is the fusion reaction which occurs in Al metal, neither in Pd nor in Ti. Both were observed on the electron bombardment of the implanted molecular hydrogen isotopes (H_2 OF D_2) embedded in Al metal.

In this experiment, hydrogen or deuteron implantation was employed, since it forms coagulation of molecules in Al [2], then the bombardment with electrons of energy 200 or 400 keV was followed. Fusion reactions were observed by detecting high energy particle emissions onto solid particle detectors, CR-39, arranged nearby the Al target. Then the detectors were etched in 6N KOH solution at 70°C for 2 hours. The bulk etching rate of the CR-39 in this condition was 2.7 V μ m/hour. The particle traces thus formed on the target facing surfaces of the detectors were counted with optical microscope. Further etching was performed for the determinations of both particle species and energies.

In exactly the same way, non-implanted Al specimens were also bombarded with the electron beam, and particle traces were counted for the background measurement. Assuming homogeneous emissions, roughly $1\text{-}2\times10^3$ particle emissions in whole space including both hydrogen and helium isotopes were observed. The fusion cross section corresponding to the particle emissions was about $2\text{-}4\times10^{-32}$ cm^2.

Collisions between recoiled D atoms due to the high energy electron impact give only 10^{-12} to 10^{-26} times smaller fusion rates than the experimental results. The present observations suggest the presence of a new kind of fusion reaction which occurs with negligible kinetic energy of the reacting nuclei.

The mechanism for the electron impact H-H and D-D fusion is proposed. This mechanism is based on the β-disintegration of protons, either a constituent of H_2 molecules in the H-H fusion case, or a constituent of deuteron nucleus in the D-D fusion case, by high energy electron capture. Energetics are given which enable the β-disintegration of the bound protons to occur in both H-H and D-D fusions.

1] H.A. Bethe and C.L. Critchfield, *Phys. Rev.* 54 (1938) p 248.
2] K. Kamada, *J. Nucl. Mater,* 169, 1989, p 141.

JAPAN - ENERGY AT 14.1 MeV

J. Kasagi, K. Ishii, M. Hiraga and K. Yoshihara (Tohoku Univ., Sendai, Japan), "Anomalous concentration of ^3He in TiD_x observed in deuteron bombardment," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

As described in our other contribution, we have found a sharp peak at 14.1 MeV in an energy spectrum obtained in a 150-kev deuteron bombardment of TiD_x. The peak was assigned to be protons originated from the $^3He(d,p)^4He$ reaction with ^3He being at rest, because of the following reasons. A change of the peak energy observed for different thickness of Al absorber clearly indicates that the protons are not produced in the secondary reactions in the detector but emitted in the TiD_x target. No other deuteron induced reactions than the $^3He(d,p)^4He$ reaction can reproduce the measured energy of the peak. Furthermore, protons emitted in the sequential $D(^3He,p)^4He$ reaction following the $D(d,^3He)n$ reaction make a broad peak as observed in the spectrum.

Of particular interest is the fact that the peak does not always appear and hence, production of ^3He seems to be severely limited at some particular places in TiD_x. Up to the present, we have had only three cases which clearly show the peak,

out of more than 50 measurements. The quantity of ^3He can be estimated from the ratio of the yield of the peak to that of the D(d,p)T reaction. They are ranging from 10^{-6} to 10^{-4} for the three cases.

It is very difficult to explain the above mentioned by usual production processes. Neither the primary D(d,n)^3He reaction in the deuteron bombardment, nor existence of ^3He in D_2 gas can explain the observed yield at all. It is thus inferred that the observed concentration of ^3He in TiD_x is due to the nuclear transmutation which occurs during D_2 gas loading into Ti.

As reported so far, it is the characteristic of the so-called cold fusion that it seldom occurs and hence its reproducibility is quite low. In the present work, although we have not yet specified the conditions under which ^3He is produced in Ti, we are able to say the following. The peak was observed when the TiD_x rod with the atomic ratio of D/Ti being larger than 1.3 was used as a target, and only when a peripheral region of the cracked and split section of the rod was bombarded; the peak disappeared when we changed the beam position to bombard a central region of the section. Thus, the present result strongly indicates that the surface of the rod is very important for the anomalous concentration and/or production of ^3He in Ti during D_2 gas loading.

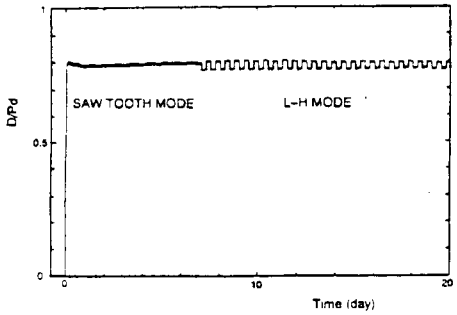
JAPAN - TAKAHASHI REPLICATION

Masafumi Kobayashi, Norio Imai, Norifumi Hasegawa, Keiji Kunimatsu (IMRA Japan Co., Ltd.), Sapporo, Japan), "Measurements of D/Pd and Excess Heat During Electrolysis of LiOD in a Fuel-Cell Type Closed Cell Using a Palladium Sheet Cathode," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Measurements of D/Pd and excess heat during electrolysis of LiOD in a fuel-cell type closed cell using a palladium sheet cathode were carried out. We used the "saw-tooth current mode" and the following "L-H current mode" which is similar to the method by Takahashi of Osaka University.

A cold worked pure Pd plate (1 mm thick 25x25mm) from Tanaka Kikinzoku was used as the cathode which was supported by two small PTFE bricks. The anode was a gas diffusion type electrode which was placed parallel to the Pd cathode. The minimum anode-cathode distances was 6mm (or 10mm) for both sides. Loading ratio, D/Pd, was calculated by measuring D_2 gas pressure and temperature. We started the "pre-loading phase" with the "saw tooth current mode" between 0.25A and 5A which was continued for 7 days. From 8th day we switched to the L-H current mode operation by changing the current between 0.25A and 5A every six hours. We report the conclusion of the experiments during about 2 months.



D/Pd vs. Time on Pd(C)sheet cathode in 1M LiOD at 293K

JAPAN - BIOLOGICAL TRANSMUTATIONS

Hisatoki Komaki (Biological and Agri. Research Inst., Otsu, Japan), "Observations on the Biological Cold Fusion or the Biological Transmutation of Elements," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

In previous paper [1]~[6], the author, with Prof. Dr. C. Louis Kervran, suggested the probable occurrence of the biological cold fusion or the biological transmutation of elements. In order to confirm the phenomena, under the more controlled condition, potassium, magnesium, iron and calcium were determined in cells of *Aspergillus niger* IFO 4066, *Penicillium chrysogenum* IFO 4689, *Rhizopus nigricans* IFO 5781, *Mucor rouxii* IFO 0396, *Saccharomyces cerevisiae* IFO 0308, *Torulopsis utilis* IFO 0396, *Saccharomyces ellipsoideus* IFO 0213 and *Hansenula anomala* IFO 0118, cultured in normal medium and media deficient in one of potassium, magnesium, iron or calcium. Values of potassium 1890~2650 μg, magnesium 380~510 μg, iron 95~120 μg, and calcium 60~95 μg were obtained per g dried cells cultured in each deficient medium, while potassium 8650~11050 μg, magnesium 1920~2160 μg, iron 510~680 μg, and calcium 380~450 μg were found per g dried cells obtained by cultivation in the normal medium.

The author would like to suggest the probable occurrence of the phenomena relevant to biological cold fusion.

References:

(1) Hisatoki Komaki, "Production de proteins par 29 souches de microorganismes et augmentation du potassium en milieu de culture sodique, sans potassium," *Revue de Pathologie Comparee,* 67, 213-216, 1967.

(2) Hisatoki Komaki, "Formation de proteines et variations minerales par des microorganismes en milieu de culture, sort

avec ou sans potassium, sort avec ou sans phosphore," *Revue de Pathologie Comparee*, 69, 83-88, 1969.
(3) Hisatoki Komaki: C.L. Kervran, "Experiences de Komaki, Premiere Serie de Recherches," Preuves en Biologie de Transmutations a Faible Energie, Paris, 1975, p. 116-120)
(4) Hisatoki Komaki: C. Louis Kervran, "Deuxieme Serie D'Experiences de Komaki," Ibid., p. 120-121
(5) Hisatoki Komaki: C. Louis Kervran, "Troisieme Serie D'Experiences de H. Komaki," Ibid., p. 122-130)
(6) Hisatoki Komaki et al., Proceedings of 13th international Congress of Biochemistry, Amsterdam, Holland

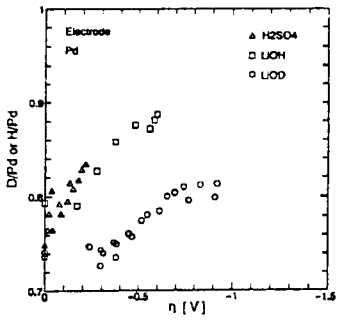
JAPAN - OVERVOLTAGE AND LOADING

Akihiko Kubota, Hidemi Akita, Yumiko Tsuchida, Toshiya Saito, Akiko Kubota, Norifumi Hasegawa, Norio Imai, Nana Hayakawa, Keiji Kunimatsu (IMRA Japan Co., Ltd., Sapporo, Japan), "Hydrogen and Deuterium Absorption by Pd Cathode in a Fuel-Cell Type Closed Cell," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The hydrogen and deuterium loading ratio, H/Pd and D/Pd, in Pd cathode were measured during electrolysis of 1 M LiOD, 1M LiOH and 2.8M H_2SO_4 in a fuel-cell type closed cell. Cold worked pure Pd (ϕ2- ϕ5 rods) were used for cathodes. A gas-diffusion type fuel cell anode was used for ionization of hydrogen and deuterium gas. H/Pd or D/Pd was calculated from H_2 or D_2 gas pressure decrease and temperature during electrolysis under in-situ conditions.

The result is summarized as follows; the loading ratio depends on hydrogen overvoltage. D/Pd is smaller than H/Pd by 4-8% for a given overvoltage. The loading ratio does not depend on electrolyte, but the overvoltage depends on electrolyte for a given current density.



D/Pd or H/Pd vs. Overvoltage for ϕ 2 Pd rod in 1M LiOD, 1M LiOH and 2.8M H_2SO_4 at 30°C

JAPAN - TAKAHASHI NEUTRONS

Takehiro Kusunoki, Mutsuhiro Nakata, Yasuhiko Fujii and Makoto Okamoto (Research Lab. for Nuclear Reactors, Tokyo Inst. of Tech., Japan), "Energy of the Neutrons Emitted in Heavy Water Electrolysis," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

To elucidate the mechanism of the neutron emission in the heavy water electrolysis,we have carried out a series of experiments of the constant current electrolysis of the heavy water with many types of Pd cathode. In these experimental runs, the anomalous neutron bursts were observed sometimes. But the reproducibility has been found to be very poor.

Takahashi et al. reported that their low/high pulse mode electrolysis gave the neutron emission with a high reproducibility and with two components of weak neutron emissions.

In the present work, the L/H pulse mode electrolysis has been introduced to carry out the experimental study to clarify the dependency of the L-H modes operation of electrolysis on the neutron emission from the Pd cathodes. The L-H modes employed here were modified from Takahashi's mode in the pulse repetition period, in the current density and in the shape of the electrodes. The preloading process of D_2 gas into Pd cathode are also different from Takahashi's process. The current density was varied from 20 to 40 mA/cm^2 and from 80 to 240 Ma/cm^2 for L mode and H mode, respectively. The electrolysis were mainly operated with the rectangular pulse with rather short repetition period of one hour. The Pd cathode used in this work were rectangular Pd plates with different dimensions. Enclosing the test cell, three neutron detection systems are employed. One is composed of 6 ^{3}He counters, the second is 3 ^{3}He counters, the last one is the neutron energy spectrometer consisting of NE213 liquid scintillator of 5 x 5 inches with a multi channel analyzer.

Among 8 runs of the electrolysis of L-H pulse mode operations, 4 of them gave appreciable neutron emission without any correlation to the dimensions of the cathodes and the D/Pd ratios at the preloading process. The intensity of the detected neutrons was so small that the signals from the two ^{3}He neutron detection systems could not be evaluated. The neutron energy spectrum integrated throughout the operation time were found to have the two components (2.45 MeV and higher energy) and the intensity of the 2.45 MeV neutron is smaller than that of higher energy neutrons. These results are just same as results reported by Takahashi et al. for all of the four neutron emissions. This fact should be

recognized as a very significant finding for the cold fusion research, because the findings on the neutron energy reported by Takahashi et al. were completely confirmed by the present study.

JAPAN - NUCLEAR EMULSIONS

Takaaki Matsumoto (Department of Nuclear Engineering. Hokkaido University, Sapporo, Japan) "Review for "Nattoh" Model and Experimental Findings During Cold Fusion." Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan."

AUTHOR'S ABSTRACT

The phenomena of cold fusion seem to be very complicated, For example, the inconsistent production rates of heat, neutron, Tritium and Helium. Drastic changes of thinking would be required to understand the mechanisms of cold fusion. Here a review is described for the Natrob model, that based on a new fusion reaction associated with no neutron emission, was extensively developed to understand the general framework of cold fusion.

The Nattoh model proposes that the fundamental principle of cold fusion is the self-compression of hydrogen-clusters that takes place in highly compressed states of hydrogens and that a new fusion reaction, "hydrogen-catalyzed fusion reaction" follows. The reaction emits a new particle "iton" that might consist of electrons, positrons and neutrinos instead of neutron. High energy hydrogens resulted by the fusion reactions can maintain chain-reactions that produce the excess energy with two modes of steady and burst burnings. Multi-body fusion reactions can be easily enhanced in the self-compressed state of hydrogen-clusters to produce heavy elements. Furthermore, it can be expected that multiple-neutrons such as quad-neutron finally gravity-decay to cause tiny blackholes and whiteholes.

Experimental findings that can verify the model were recorded on nuclear emulsions. When the iton is produced, it has the mesh-structure that is determined by the compression and those breaks up were observed. The micro-explosions were also observed for the gravity-decays of bare quad-neutrons and "itonic" quad-neutrons that are covered by the iton. The other observation of that plural fusion reactions simultaneously occurred directly verified the principle of the Nattoh model. The multiple neutrons can escape from electrolysis cell and bombard the nuclei of the nuclear emulsions to produce those 'star' traces that were observed. Nuclear transmutations such as heavy elements production were observed by the analysis of SEM-EDX. Furthermore the productions and evaporations of tiny blackholes were observed. Whiteholes were also observed.

Cold fusion is a small scale simulation of events that occur in a cold star faraway in the universe. Now we can reproduce the nobles of the universe in our laboratory.

JAPAN - FISSION TRACK METHOD

O.Matsumoto, K. Kimura, Y. Saito, H. Uyama, T. Yaita, A. Yamaguchi, and O. Suenaga (Dept. of Chemistry, Aoyama Gakuin University, Tokyo, Japan), "Detection Of Neutron And Tritium During Electrolysis Of D_2SO_4-D_2O Solution," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

When the electrolysis of 0.5M D_2SO_4-D_2O solution was carried out, using Pd as a cathode material and Pt as an anode material, the emission of neutrons was detected by means of the fission track method and the production of tritium was investigated with a liquid scintillation method.

The neutron detection during the electrolysis of 0.5M D_2SO_4 -D_2O solution and 0.5M H_2SO_4-H_2O solution using Pd plate as the cathode material was carried out in order to investigate the effect of the electrolyte solution. Although the number of fission tracks after the electrolysis of H_2SO_4-H_2O solution was approximately the same with that observed in the dummy detector, the number of tracks detected in the detector after the electrolysis of D_2SO_4-D_2O solution was 1.7 times higher than that in the dummy detector. The increase of the track number in the electrolysis of the D_2SO_4-D_2O solution would be due to the (n,f) reaction of ^{235}U by the impinging of the neutrons emitted during the electrolysis. The neutron emission rate is estimated to be comparable with that of natural abundance of neutrons at the surface of the earth. The natural abundance of neutron with cosmic-ray radiation was estimated to be 2 neutrons cm^{-2} s^{-1} using fission track method comparing with the neutron radiation from the ^{241}Am-^{9}Be neutron source.

The ß-ray radiation from the electrolyte and the cathode materials, which were used for the electrolysis, were measured by the liquid scintillation method. In the first case, the ß-ray radiation from the electrolyte of D_2SO_4 -D_2O after the electrolysis was measured by liquid scintillation method comparing with that from the H_2SO_4-H_2O electrolyte solution as a reference. The activity in the electrolyte of D_2SO_4 -D_2O increased remarkably by the electrolysis and the increment of the activity was one order of magnitude higher than that in the H_2SO_4 -H_2O solution. The second method was the ß-ray radiation measurement from the Pd plate immersed in the liquid scintillator after used as the cathode materials for the electrolysis of D_2SO_4 -D_2O and H_2SO_4 -H_2O solutions. The increment of activity in the electrolysis of D_2SO_4 -D_2O solution was several times larger than that in the

H_2SO_4 -H_2O solution, because the inclusion of deuterium as well as hydrogen into the Pd plate was observed by means of X-ray diffraction method. The tritium production rate during the electrolysis of the D_2SO_4 -D_2O solution is estimated to be 10^4 T atoms ml^{-1} s^{-1}in the electrolyte solution and 10^4 cm^{-2} s^{-1} in the Pd cathode, respectively.

The branching ratio of tritium production rate to neutron emission rate during the electrolysis of D_2SO_4 -D_2O solution was the order of magnitude of 10^4. This is comparable to that reported by Mizuno et al. (10^4) [1].

1. T. Mizuno, T. Akimoto, K. Azumi, and N. Sato, *Denki Kagaku*, 59, 798 (1991).

JAPAN - KEY TO REPRODUCIBILITY

Noriaki Matsunami (Crystalline Materials Science, School of Engineering, Nagoya University Furo-cho, Japan). "A Mechanism for Cold Nuclear Fusion: Barrier Reduction by Screening under Transient Coherent Flow of Deuterium," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan."

AUTHORS' ABSTRACT

A mechanism for the cold fusion is suggested, based on reduction of the barrier penetration factor λ due to the electronic screening in solid metals under transient coherent flow of deuterium. To the cold fusion be observable with the fusion rate of ~1 fusion/s•cm3, λ should be less than 70. [1] During electrolysis of D_2O and discharge after charge of D_2 by high pressure or energetically implantation, the ratio of d over metal atom would be close to unity and hence the coherent movement of d is expected, unless otherwise no space is available for d. Under the transient coherent motion, deuterium passes through the exited states. At the excited states, ionicity of d or the electron density around d would increase and thus reducing λ. For d- state, λ of ~70 is obtained. The fusion rate depends critically on the effective time being at the excited states, effective region of coherent movement, the d/metal atom ratio and etc, resulting in the extreme fluctuation of fusion rate or irreproducibility.

1. N. Matsunami, Radiation Effects and Defects in Solids, 112(1990) p 181.

JAPAN - EXCESS HEAT BY PULSING

Hiroyuki Miyamaru, Akimasa Mega and Akito Takahashi (Dept. of Nuclear Eng., Osaka University, Japan), "Periodically Current-Controlled Electrolysis of D_2O/Pd System for Excess Heat Production," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Periodically current-controlled electrolyses of D_2O/Pd systems were performed with various functions for the observation of cold fusion phenomena. New calorimetric technique was utilized to measure excess heat of more than several watts level.

An electrolysis cell is specially designed as an open cell and a strong external cooling apparatus is installed in the cell to minimize the time that the cell needs to reach thermal equilibrium. To mitigate the effect of bubbling and thermal convection, electrolyte is stirred and the cell temperature distribution is monitored at several points. Heat level is calibrated by averaging equilibrium temperatures of all points, so as to meet the integrated (one-point) energy balance of the system. In addition to electrolyte temperature, the difference of coolant temperatures between inlet and outlet is also monitored to "double-check" heat production.

Slight excess heat of 2-3 watts level was observed during the saw-tooth (from 30mA/cm^2 up to 300mA/cm^2 with 20min period) and the step-up (6-8 steps) operations. Though correlations between current patterns and excess heat levels are not clear, the periodically current-controlled operation tends to activate deuterized Pd cathode and to trigger excess heat production. Some other experiments (electrolysis patterns, effects of LiOH and fresh D_2O addition, and configuration of electrodes-set) have been carried out to find critical parameters for the production of anomalous excess heat. Observation of nuclear products (tritium and ^{4}He) is under planning so far.

JAPAN - NO PROTONS

S. Miyamoto, K. Sueki, H. Iwai, M. Fujii, T. Shirakawa, H. Miura, T. Watanabe, H. Toriumi, T. Uehara, Y. Nakamitsu, M. Chiba, T. Hirose, and H. Nakahara (Faculty of Science, Tokyo Metropolitan University, Japan), "Measurement of Protons and Observation of the Change of Electrolysis Parameters in the Galvanostatic Electrolysis of the 0.1M-LiOD/D_2O Solution," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

Introduction:
Detection of protons is generally more sensitive than that of neutrons due to its lower background. In the present work, protons were measured to confirm the cold fusion phenomena that might proceed through the reaction: $d+d \rightarrow {}^3H + p$.

Experimental:

Galvanostatic electrolysis of the 0.1M-LiOD/D_2O solution was carried out under a constant current of 200mA (100mA/cm^2) with a 25μm thick Pd foil as a cathode. A 5.3cm^2 surface Si barrier detector (SSD) was used for detection of protons. The void space in between the Pd foil and the SSD was evacuated with a rotary pump for reducing the influence of Rn in the air on the detector signals and for avoiding the energy reduction of protons. The 0.5%-Pd alumina pellets were used as catalyst to recombine the D_2 and O_2 gas into D_2O in order to keep the amount of the electrolyte even after a long period of electrolysis. The current, input voltage, reference voltage and the electrolyte and room temperature were monitored. After electrolysis, Li contents in the electrolyte, in the catalyst, and in the Pd foil were measured by ICP-AES.

Results:
(1) Measurement of protons
Measurements of protons were performed twice for the $LiOD_{aq}$ and once for $LiOH_{aq}$. No protons were observed above the background level and the upper limit of the cold fusion rates calculated from the number of events observed in the 1501-2400ch were 1.29 X 10^{-24} fusion/d-d pair/sec in RUN001 and 1.52 X 10^{-24} fusion/d-d pair/sec in RUN002. For the calculation, the ratio of d/Pd was assumed 1.0.

(2) Observation of the change of electrolysis conditions
The electrolyte temperature reached above 353K after 6 days in RUN001. But unfortunately, the input voltage and the room temperature were not measured in this run, and we could not definitely conclude that we observed excess heat. To observe excess heat, we performed two more runs by monitoring both input voltage and the room temperature. In the first run, we observed an increase of the input power after 14 days, while the electrolyte temperature decreased unsteadily. (RUN004) In the second run, the space in between the Pd foil and the SSD was not evacuated and then, no such an increase of the input power and a decrease of the electrolyte temperature was observed. (RUN005)

(3) Li contents before and after the electrolysis
Li contents before and after the electrolysis were measured by ICP-AES. While the volume of the electrolyte solution decreased typically from 20ml to 6ml in 22 days, Li concentration reduced to less than half of its initial concentration. In RUN004, presence of a white substance was recognized on the back of the Pd foil and in the vacuum system. This white substance was found to contain Li by ICP-AES elemental analysis.

JAPAN - NEUTRONS AND LOADING

Tadahiko Mizuno, Tadashi Akimoto (Kazuhisa Azumi Dept. Nuclear Eng., Fac. Eng. Hokkaido Univ., Japan) and Michio Enyo (Catalysis Research Center, Hokkaido Univ., Japan),

"Cold Fusion Reaction Products and Behavior of Deuterium Absorption in Pd Electrode," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We have reported earlier a weak neutron emission of 2.45MeV energy, tritium generation reaction which had 10^4 times higher rate compared with that of neutron, and the excess heat production during cathodic polarization of Pd. These products were evolved when the D/Pd loading ratio reached high values such as 0.8 ~ 0.95.

Experiments were performed at around 100°C and current density of several hundred Ma/cm^2. The deuterium absorption process showed two steps; the first step occurred immediately after the start of electrolysis and the second step started when the loading ratio reached the value of β phase. The absorption rate in the second step was slower than the first step by two orders of magnitude. The loading ratio exceeded the value obtained by a gas absorption method. The slow step showed a linear relationship with time; it suggests that the process was controlled by a surface reaction.

The loading ratio attained after the slow step was completed was controlled by the electrolysis conditions such as temperature and current density. For example, the D/Pd ratio reached nearly unity at 30°C and 50 Ma/cm^2. Further the D/Pd ratio value measured by a deuteron irradiation method, which was restricted to the region near the surface, was very high, being 1.4 at 50mA/cm^2, 30°C.

The rate of deuterium absorption was observed to be proportional to the cathodic current density in a certain temperature range. A semi-empirical relationship between equilibrium deuterium pressure (P_{eq}) and the current density (i) was obtained as $P_{eq} \approx ki$ where k is a constant. On the other hand, the relationship between the equilibrium concentration (C/C_o), and the normalized dissociation pressure (P/P_o), when it exceeded the β phase, at temperature T, may be expressed as,

$$\frac{P}{P_0} + k_2 \exp\left(\frac{C}{C_0} - \frac{\Delta H}{RT} + \frac{\Delta S_H}{R}\right)$$

here ΔH and ΔS_H are the phase formation enthalpy and entropy respectively. We can directly estimate a D/Pd ratio from an electrolysis condition of a temperature andcurrent density by this equation. For example, We could obtain the D/Pd ratio of 0.85 and 0.90 when the sample was charged with 50 and 200 mA/cm^2 at 30°C by the relationship. It will require several A/cm^2 to obtain D/Pd ratio of unity.

JAPAN - EMPHASIS ON LITHIUM

Mutuhiro Nakada, Takehiro Kusunoki, Yasuhiko Fujii and Makoto Okamoto (Research Laboratory for Nuclear Reactors) and Osamu Odawara (Dept. of Elec. Chem., Interdisciplinary Grad. School of Sci. and Eng., Tokyo Inst. of Tech., Japan), "A Role of Lithium for the Neutron Emission in Heavy Water Electrolysis," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Lithium has been recognized as a significant element for the neutron emission and also the excess heat, in most cases of heavy water electrolysis. There has been no clear evidence to discuss the role of lithium in the cold fusion cells.

In the present work, the depth profiles of lithium and deuterium have been deduced from SIMS analysis data of these two elements in the surface region of the Pd electrodes used in the heavy water electrolysis with LiOD. The SIMS analysis was performed on a Secondary Ion Mass Spectrometer (IMS-4S, CAMECA/France).

Very clear differences in the depth profiles were confirmed between the cathodes operated by the constant current operation and by Low-High pulse mode operation. In the former, lithium and also deuterium depth profiles are simply monotonic decreasing curves; on the other hand, the latter gave curves with some structures. And it should be noticed that the lithium concentration in the constant current operation is higher than that in L-H mode operation, but the deuterium concentration is lower. The sensitivities of the two elements are very much different in the SIMS analysis, so the absolute concentrations cannot be compared. It can be said that the significant part of the current would be consumed by the migration of lithium ions into the electrode in the constant current operation comparing to the L-H mode operation.

The features of the profiles of lithium and the deuterium are quite similar in every case. The distribution of deuterium in the surface of the electrode was found to be controlled by the operation modes including the current density and the behavior of lithium ions.

The tremendous difference is observed in the profiles of lithium and deuterium between the electrodes with neutron burst and without neutron burst. The former gave the profiles with some structures in lithium and deuterium and with one order high concentration of deuterium. All of these curves were given in the L-H mode operation. The similar monotonic curves as found in the constant current operation were obtained in a low current density operation of L-H mode, and these two cases did not give any appreciable neutron emission.

According to the above findings, a role of lithium ions in the deuterium accumulation process in the surface region of the electrode and for the neutron burst will be discussed in the presentation.

JAPAN - USE OF THIOUREA

Toshihide Nakata, Yumiko Tsuchida, Keiji Kunimatsu (IMRA Japan Co.,Ltd., Sapporo, Japan), "Absorption of Hydrogen into Pd Foil Electrode: Effect of Thiourea," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Cold fusion phenomenon in Pd cathode is said to occur only under condition of loading ratio of D/Pd > 0.9. Therefore, the way the amount of deuterium in Pd is increased is very important.

The equivalent hydrogen pressure P_{H_2}* which is correlated with loading ratio of H/Pd is lead as follows.

$P_{H_2}^* = P_{H_2} \exp(-2F\,\eta_2 / RT)$

η_2 :overpotential of Tafel step ($2H(a) \rightarrow H_2$) for hydrogen electrode reaction

P_{H_2} :hydrogen gas pressure

We tried the absorption of hydrogen into Pd cathode in acidic and alkaline solutions containing thiourea which poisons Tafel step and accordingly increases η_2, P_{H_2}* and H/Pd.

Electrolytic hydrogen absorption into Pd foil electrode (50 μ m thickness) was investigated in the absence and presence of 30 μ M thiourea in 0.5M H_2SO_4 and 0.4M LiOH. The amount of hydrogen absorbed under cathodic polarization was determined by the integration of the ionization current of hydrogen when Pd electrode was polarized anodically.

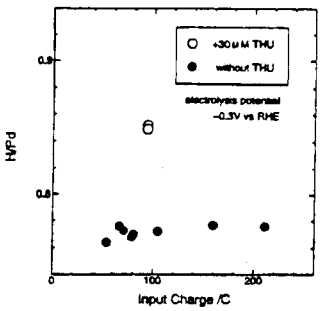


Fig.1 H/Pd vs. Input Charge in 0.5M H_2SO_4 at 283K

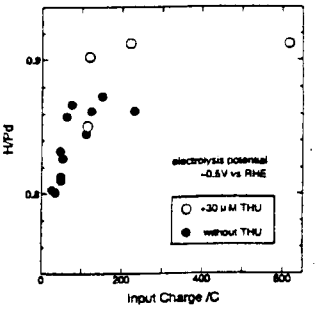


Fig.2 H/Pd vs. Input Charge in 0.4M LiOH at 283K

After THU addition in acidic and alkaline solution H/Pd increased by about 7% and 5%, respectively. Further we tried the absorption of deuterium into Pd and have found a similar effect of thiourea to increase D/Pd.

JAPAN - LIGHT-WATER ELECTROLYSIS

Reiko Notoya and Michio Enyo (Catalysis Research Center, Hokkaido Univ., Japan), "Excess Heat Production in Electrolysis of K_2CO_3 Solution with Ni Electrodes," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Mills et al. reported excess heat production in the electrolysis of potassium carbonate solution on nickel foil cathode. The present report is concerned with (a) reproduction of Mill's result by conducting similar experiments and (b) attempt of increasing the amount of the excess heat production, with use of porous nickel electrode of 0.1 cm^3 volume and 1.5 cm^2 total apparent area was used as the cathode. A cell of one compartment type was used and a wire heater was placed in it to provide a reference heat source. The solution used was 0.5 K_2CO_3. The cell was cooled by a constant rate air stream and maintained at 20°C during all the measurements. Typical results indicated that the excess heat production rate was proportional to the input power in the range of measurements (up to 4 W) and it is made far larger than reported by Mills et al., namely, 3 to 4 times larger than the input power, after corrected for the thermoneutral potential. Further experiments are being continued to detect calcium on the supposition of the nuclear reaction,

$$\frac{1}{1}H + \frac{39}{19}K - \frac{40}{20}Ca + 8.33\ MeV.$$

JAPAN - CATHODE PREPARATION

T. Ohi, T. Sano, T. Terasawa, and S. Nezu (IMRA Material R & D Co., Ltd., Aichi, Japan), "Preparation of Pd Electrodes and Their Hydrogen Loading," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We prepared several palladium-based electrodes with various compositions and processing conditions. The electrodes were evaluated in terms of hydrogen loading ratio.

Preparation of Electrodes:

Palladium grain (99.99%, 3-5 mm dia.) was used as a mother alloy. Button-shaped mother alloys of Pd-Ag and Pd-Ce were prepared by arc-melting of the palladium grain and the respective metals (Ag: 99.9%; Ce: 99.7%). The mother alloys were cast into rods (8 mm dia.) by high frequency induction melting (1650°C) under an argon atmosphere. The cast rods were then annealed for 1-2 hours at 750°C under a vacuum or an argon atmosphere. The rods were then subjected to cold-work by swaging several times. The diameter of the final rods was set to 2 mm. For the purpose of comparison, some of the rods were then annealed at 650°C under an argon atmosphere.

Measurement of H(D) Loading Ratios:
The Pd-based cathodes (2 mm dia., 10 mm length) were electrolyzed in H_2O (or D_2O) at 25-30°C (electrolyte temperature) using platinum as an anode and 1 N LiOH (or LiOD) as an electrolyte. The electrolysis was carried out galvanostatically at the current density of 300 mA/cm^2. The amount of evolved hydrogen gas was measured using a mass flow meter (KOFLOC, Mode13710). The amount of the hydrogen absorbed in cathodes was obtained by subtracting the evolved hydrogen gas from the amount of the hydrogen theoretically calculated from the quantity of electricity.

Results:
The electrodes were normally saturated with hydrogen in about 3 hours from the start of electrolysis. The saturation was confirmed by the 100% recovery of the gas. Figure 1 shows the hydrogen loading ratios of Pd-based alloys with various contents of Ag or Ce. As is shown, the loading ratios decreased with the increase of Ag or Ce. The comparison of H and D is shown in Table 1. Table 1 also shows the effect of annealing of electrodes. In this study, annealed electrodes always gave higher loading ratios than unannealed ones.

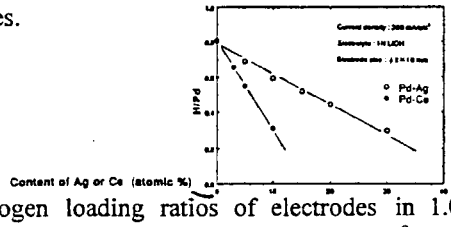


Fig. 1

Table 1. Hydrogen loading ratios of electrodes in 1.0 N LiOH (LiOD) at the current density of 300 mA/cm^2.

electrodes	protium		deuterium
	unannealed	annealed	unannealed
Pd_{100}	0.807	0.832	0.818
$Pd_{90}Ag_{10}$	0.614	0.634	0.611

JAPAN - LIGHT-WATER ELECTROLYSIS

T. Ohmori and M. Enyo (Catalysis Research Center, Hokkaido University, Japan), "Excess Heat Produced During The Electrolysis On Ni, Au, Ag, and Sn Electrodes In Alkaline Media," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Mills et al. claimed recently a production of ca. 130mW excess heat in Ni/K_2 CO_3 light water system [1]. Bush suggested that this heat originated from the reaction, $_{19}K^{39}$ + $_1p^1 \rightarrow {}_{20}Ca^{40}$. The present study is intended to reproduce their results on Ni, and further to investigate the same possibility on other metals such as Au, Ag, and Sn electrodes on which under-potential deposition (upd) or inclusion of alkali metals are known to take place under high cathodic polarization [2-3].

The electrolysis was conducted with a constant current (1A) in 0.5 M K_2CO_3, Na_2CO_3, Na_2SO_4 and Li_2SO_4 solutions. The ambient temperature was controlled at 25±1°C using an air thermostat. The input power was 4.5 - 5.3 W.

The excess heat was steadily observed over a period of several days on all the electrodes used in K_2CO_3 solutions, which estimated to be 387, 328, 620 and 907 mW, at Ni, Ag, Au, and Sn electrodes, respectively. They correspond to excess heat of 7 - 20% of the input. A comparable amount of excess heat also observed on Au electrode in Na_2CO_3 and Li_2SO_4 solutions. On the other hand, no noticeable amount of excess heat was observed on Ni electrode in Na_2SO_4, Na_2CO_3, Na_2SO_4 and Li_2SO_4 solutions

References:

[1] R.L. Mills and S.P. Kneizys, *Fusion Technology* 30 (1991) 66.
[2] T. Ohmori and M Enyo, *Electrochimica Acta* 37 (1992) 2021.
[3] B.N. Kabanov et al., *Usp. Khim* 34 (1965) 1813.

JAPAN - MECHANICALLY-TREATED Pd

Ken-ichiro Ota, Mitsuru Nakamura, Masaki Kuratsuka, Kotoji Ando, Yoshihiro Iida, Hideaki Yoshitake and Nobuyuki Kamiya (Dept. of Energy Eng., Yokohama National Univ., Japan), "Heat Production At The Heavy Water Electrolysis Using Mechanically Treated Pd Cathode," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Since the announcement of Fleischmann-Pons effect, many researches have been done on the heat measurement at the heavy-water electrolysis using the Pd cathode. Most of the papers that claimed the large heat production used the open-type electrolysis. The same result should be obtained using the closed cell if the Fleischmann-Pons effect is correct. Using the closed cell, the heat balance can be obtained directly since the electrical input energy is completely converted to thermal energy. In this study the heat productions have been measured at the heavy-water electrolysis using the Pd cathode in the closed system.

Our measurements have been carried out by using the flow calorimeter with the acrylic electrochemical cell equipped with the internal catalyst for the recombination of D_2 and O_2 evolved. The electrolysis was usually operated at the constant input power, normally at 10 W. The current density was varied from 200 to 1000 mA/cm^2. The electrolyte was 0.1 M or 1 M LiOD heavy water solution. 1 M LiOH light water solution was used as the reference. The rods of 3N Pd and 10%Ag-Pd alloys of 2 mm or 5 mm in diameter were used for the cathodes.

Among the 12 runs in heavy-water electrolysis, 4 runs used the mechanically treated Pd cathode. After the cold roll, Pd metal was quenched from 750°C in order to get the fine grain size and compressed in order to promote the internal stress. Without these treatments the steady state excess heat could not be observed. However, during 2 out of 4 runs that used the mechanically treated Pd cathode, the steady state excess heat was observed. The excess heat was 5% to 9% and started after one month of electrolysis. The excess heat continued for several days. Although the reproducibility should be checked more, these treatments possibly promote the excess heat.

JAPAN - LOADING MEASUREMENTS

Noboru Oyama, Nobushige Yamamoto and Tetsu Tatsuma (Dept. of Applied Chem., Tokyo Univ. of Agriculture and Technology, Japan) "In-Situ Electrochemical Quartz Crystal Microbalance Studies of Water Electrolysis at a Palladium Cathode," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The in-situ electrochemical quartz crystal microbalance (EQCM) technique has been applied to study, electrolysis of water containing 0.2 M $LiClO_4$ (or $NaClO_4$) at Pd electrode. The resonant frequency of the Pd-coated quartz crystal was found to decrease and increase during the reduction and oxidation processes, respectively. However, the observed decrease in frequency does not always reflect the absorption of hydrogen into the Pd lattice alone but also stress production in the film, morphology change of film surfaces, etc. owing to hydrogen loading.

When 5.0-Mhz AT-cut and BT-cut quartz crystal plates were coated with the same thickness of Pd thin-film. The plots of frequency changes at AT-cut and BT-cut quartz crystal electrodes vs. charge passed during the electrolysis yielded straight lines with the different slopes (Figure 1). Tension in a crystal reportedly produces decrease and increase in the resonant frequency for an AT-cut and BT-cut crystal, respectively, so that mass change and stress produced in the film estimated on the assumption that the morphology change causes no change in the resonant frequency. The apparent molecular weight of species absorbed into the Pd lattice is estimated as 2.94 or 8.64 in 0.2 M $LiClO_4$ or $NaClO_4$, respectively. These values indicate that not only hydrogen absorption into Pd film but also deposition of Li (or Na) onto the Pd surface may occur.

Next the underpotential deposition of Li was examined using the in-situ EQCM technique. Au-coated AT-cut quartz crystal was used for EQCM measurements in propylene carbonate containing 0.1 M $LiClO_4$ and 16 mg L^{-1} water. Figure 2 shows cyclic voltammogram and a frequency change-potential curve obtained at the first potential scan. Observed decrease in resonance frequency of the quartz crystal electrode at the electrode potential less than -0.8 V vs. Ag wire indicates the deposition of lithium on the electrode surface. The deposited film blocked the electrode reaction of ferrocene in the solution: the film is not conductive. Lithium is speculated to react with water to form insulating compounds, such as lithium hydroxide or lithium hydride, immediately after the deposition. The underpotential deposition of lithium is anticipated to occur even in electrolyte solutions with much higher content of water.

Fig. 1. Plots of the frequency change vs. the charge passed for the galvanostatic electrolysis (-0.02 mA cm^{-2}) at Pd-coated AT-cut and BT-cut quartz crystal (5.0 Mhz) in 0.2 M $NaClO_4$ aqueous solution (pH 3.0).

Fig. 2. Cyclic voltammogram (A) and a frequency change-potential curve (B) obtained in propylene carbonate containing 0.1 M $LiClO_4$ at the first potential scan.

JAPAN - HELIUM FROM COLD FUSION

H. Sakaguchi and G. Adachi (Dept. of Applied Chemistry, Faculty of Eng., Osaka University, Japan). K. Nagao (Inst. for Study of the Earth's Interior, Okayama University, Japan), "Helium Isotopes from Deuterium Absorbed in $LaNi_5$," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan."

AUTHORS' ABSTRACT

Helium is a suitable candidate in order to detect the cold fusion reaction product, because helium generated can be accumulated and condensed in a closed system. In the present study, ^3He and ^4He from the D_2 gas absorbed in $LaNi_5$ were investigated to examine the evidence of nuclear fusion reaction by using a mass spectrometer equipped with a noble gas purification system.

The reaction vessel (3.23 X 10^{-5} m^3) sealed with a copper gasket, gas samplers and vacuum-gas connecting lines were made of stainless steel to exclude helium in air. The 99.5 % pure D_2 gas was applied to the $LaNi_5$ ingot (52.5 g) at a pressure of 7.9 x 10^5 Pa. After removing the helium gas initially contained in the applied D_2 gas, a part of the residual gas was collected in a sampler. The temperature fluctuation process (77⇔to⇔300 K) to the vessel containing the hydrogenated $LaNi_5$ was repeated 135 times over a period of 130 days, and a portion of the gas separated from the D_2 gas was withdrawn into another sampler.

A VG5400 mass spectrometer and a noble gas purification system installed at Okayama University were used for helium isotopic analyses. The detection limit of helium with this apparatus was about 10^{-20} m^3 STP(10^5 atoms). For helium isotopic analyses, the mass resolutions necessary to separate the hydrogen and deuterium peaks are 510, 400 and 100 for ^3He-HD, $_3He$-H_3 and ^4He-D_2 respectively, so that the high resolution (600) collector was used for the ^3He analyses and the low resolution (200) collector was used to separate ^4He and D_2.

Nucleonic helium may be detected as an isotopic ratio different from the ratio of helium initially contained in the D_2 gas. The helium isotopic ratio, however, can be changed by air leakage and physical processes such as diffusional transport. Such an effect on the helium isotopic ratio can be elucidated by measuring the elemental abundance of neon, argon, krypton and xenon in some of the sample gases.

On the experiment using the D_2 gas, the amount of ^3He((2.74±0.83) x 10^6 atoms) and ^4He((4.09±0.64) x 10^{11} atoms) was found to increase in the gas obtained after the repeated temperature cycling, while no enrichment of helium isotopes was observed in the gas obtained by the H_2 gas. The increase in helium isotopes was not significantly affected by air contamination, because the noble gas abundance of the resulting gas was quite different from that of air. Therefore, the origin of the helium isotopes appears to be the cold fusion reaction.

JAPAN - FRACTO-FUSION

T. Shirakawa, M. Chiba, M. Fujii, K. Sueki, K. Fukushima, T. Hirose, S. Miyamoto, Y. Nakamitu, H. Toriumi, T. Uehara, H. Miura, T. Watanabe, T. Seimiya, H. Nakahara,

(Dept. of Chem. and Physics, Faculty of Science, Tokyo Metropolitan University, Japan), "Neutron Emission From Crushing Process of High Piezoelectric Matter in Deuterium Gas," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We report a neutron emission from crushing process of a high piezoelectric matter in Deuterium gas by vibration mill. The mill is composed of a 500 ml cup with a stainless steel ball (50 mm diameter) which vibrate at the frequency of 50 Hz and at vertical displacement of 5 mm. The neutrons were detected 10 ^{3}He counters arrayed circularly in a cylindrical shaped paraffin block of 50 cm outer diameter and 10 cm inner diameter. The peak position of neutron (760 keV) is kept 1600 channel of CAMAC ADC. The detection efficiency was measured as ε=1.6% by a calibrated ^{252}Cf source. The experiment was done in the low background facility at Nokogiri Mt. of the Cosmic-Ray Research Institute, Tokyo University. The count rate of background were observed 3.98 count/h at 1200-1600 channel windows. The process of crushing was continued 1 hour. After 1 hour, all solid materials were crushed to under 1μm diameter. The neutron emissions were observed during a crushing process of Lithium-Niobate single crystal in deuterium gas atmosphere. We also observed neutron emission at crushing process Lithium-Niobate + Lithium deuteride in deuterium gas. We observed the neutrons total 64 count / 12 hour in Lithium Niobate-Deuterium system. The neutron flux was 64 count / 1.6% / 12 hour = 4000 / 12 hour. The background counts rate of neutrons during the same time were 48.1 means and 8.3 standard deviation. When the statistical treatment of this results, the neutron counting rate 64 in crushing process were more excess neutron emission than back ground count rate with confidence level 98% The pressure dependence of neutron emission was not observed in 12 samples.

JAPAN - HIGH-LOW PULSING

A. Takahashi, A. Mega, H. Miyamaru and T. Iida (Dept. of Nuclear Eng., Osaka University, Japan). T. Takeuchi (Matsushita Electric Co., Osaka, Japan), "Anomalous Excess Heat By D_2O/Pd Cell Under L-H Mode Electrolysis," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Using electrode-units with plane-symmetric configuration, non-stationary current mode operations (mostly with repetitive Low-High currents of 12 hr. period) have been tried to observe excess heat and nuclear products. Electrode-units are made of 99.99% pure Pd plate cathode (25mm x 25mm wide, 1mm thick) and plane symmetrically wound Pt wire anodes of 7 turns. Calorimetry is done based on the energy balance between heat source (joule-heating of electrolysis plus "unknown" excess heat) and heat sink (heat removal by external cooling). Linear relation holds between cell temperature rise and heat level (watts), due to bubble stirring effect and rapid (less than 30 min.) thermal equilibrium time.

The first experiment of the series produced continuous excess heat of 30 watts level in average and two bursts of 100 watts level in two months [1,2]. Observed weak neutron emission (1 n/sec/source level) seemed to have "inverse" correlation with increase of excess heat level. Explanation by the multibody fusion model [2] was tried. Volumetric expansion of the Pd plate was measured after the experiment to be about 15% which corresponded to about 0.95 of D/Pd ratio. Helium analysis of the Pd plate is under way.

Trying to reproduce this anomalously high excess heat, the second and third experiments are under way with improved calorimetry. Interim results have shown several watts (about 20%) excess by the sawtooth mode, 3-6 watts excess in L-modes (0.3 to 3 watts input) and 3-10 watts in H-modes (40-100 watts input). Slightly higher neutron emission rates are being observed. However, large excess heat of 100 watts level has not been observed until the end of July 1992. To increase excess heat, we are trying various things: sawtooth, step-up (6-8 steps) and L-H modes of repetitive currents, etc..

1. A. Takahashi: "Nuclear Products by D_2O/Pd Electrolysis and Multibody Fusion," Proc. Int. Symp. Nonlinear Phenomena in Electromagnetic Fields, Nagoya, Jan. 1992
2. A. Takahashi et al.: "Excess Heat and Nuclear Products by D_2O/Pd Electrolysis and Multibody Fusion," Int. J. Appl. Electromagnetics in Materials, to be publ.

JAPAN - ELECTRO-TRANSPORT MODEL

Masayoshi Tamaki and Kanji Tasaka (Dept. of Nuclear Eng., Nagoya University Furo-cho, Japan), "Field Formation of the Condensed Matter Fusion by Electro-Transport of Deuterium in Palladium," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

This paper concerns to propose a model of electro-transport effect on deuterium in palladium for the field formation of the condensed matter fusion (cold fusion), to verify the densification of the hydrogen atomic ratio, to visualize the hydrogen distribution in palladium by neutron radiography, and to analyze its intrinsic physical property. Palladium-H(D,T) is a well-known material which shows

superconductivity. To prepare high hydrogen density ((H/Pd) ratio > 1) in palladium hydrides, electrolysis of water as well as absorption of hydrogen under cryogenic temperature had been applied. On the experiment of the field formation for the cold fusion, the same approaches had been adopted by many investigators.

When modeling the system analytically, we must take into account not only electrochemical process but also electro-transport effect on hydrogen in bulk palladium metal under electric field in the case of the electrolysis of heavy water. Diffusion of hydrogen in bulk palladium is an important subject for the formation of the field of the cold fusion. Especially the electro-transport effect is an essential factor.

First experimental run was conducted to verify the electro-transport effect on deuterium in the process of the densification of the deuterium in the palladium metal matrix. A special electro-transport palladium alloy electrode was prepared. The palladium electrode part was plated with copper and gold film to hold the deuterium in the bulk palladium. The electrode was set up in the heat pipe temperature control system. Deuterium gas (2.6 kg/cm^2) was supplied to the palladium electrode. 40 amperes - 5 volts DC was applied to the palladium electrode at 100°C for 21 days. From the X-ray diffraction analysis, the hydrogen transportation and densification in the electrode were confirmed crystalographically.

Second run was carried out for the analysis of hydrogen distribution in palladium. The experimental condition of the electro-transport was the same as that of the first run. Hydrogen distribution was tested nondestructively using neutron radiography about the electro-transported palladium hydride for the operation periods of 3, 6 and 9 weeks. The redistribution of hydrogen in palladium hydride by the electro-transport was visually confirmed. The homogeneous hydrogen of initial (H/Pd) ratio of 0.67 was redistributed to the linear distribution from 0.55 at the positive electrode side, to 0.70 at the negative electrode side. From the hydrogen distribution, the effective electronic charge number of the hydrogen atom in palladium hydride was evaluated to be about 0.30+/-0.05. This value is somewhat lower than the literature value (0.54) due to much higher hydrogen content (0. 55-0.70 in (H/Pd) ratio) in the present case than 0.01 in (H/Pd) ratio in the literature cases.

In conclusion, the electro-transport effect on deuterium in palladium deuteride was proposed for the modeling of the field formation of the condensed matter fusion (cold fusion). The effectiveness of the electro-transport for the hydrogen densification in the palladium hydride was confirmed by the X-ray diffraction analysis as well as neutron radiography.

JAPAN - Pd ELECTRODE TEMPERATURE

Yoshihito Tanaka (Tokushima Research Center, Japan), "Decreasing Of Temperature Observed With Pd Wire Used For The Electrode In Electrolysis," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

It is considered that the reaction of cold fusion should be the same one in the sunspot and in the flare around the sunspot. We have experimented whether the Pd wires used in electrolysis cause the same heat absorption in the sunspot and the same explosive heat producing in the flare.

Experiment 1
1) Two test tubes with light-water of 5cc and two test tubes with heavy-water of 5cc were prepared.
2) One of the two test tubes was set between small magnet of 800 Oe.
3) The Pd wire of 0.125 mm ϕ and 10 cm length was used for a negative electrode and a Pt wire of 0.3mm ϕ was used for a positive electrode.
4) DC regulated current of about 40 mA has been supplied for 3 days.

Experiment 2
After the above electrolysis reaction,
1) The above four Pd wires were wound around each alcohol reservoir of the thermometer and covered with 3~4 folded cellophane tape.
2) A new Pd wire was wound around the alcohol reservoir of another thermometer for a standard reference.
3) These five Pd wires were connected in series and set in an incubator. Total resistance of them was 8.4Ω.
4) AC commercial current was supplied for a month. The scale of the alcohol thermometer was raised to 60 - 70 degrees.

Results and Discussion: The obtained variation of these temperatures is shown in Fig. 1. The indicated values in Fig. 1 are given by subtracting the standard temperature because they move with room temperature. It is clearly found that the temperature of the thermometer winded with Pd wire used for electrolysis of D_2O held between magnets, D_2O (M), decreases day by day.

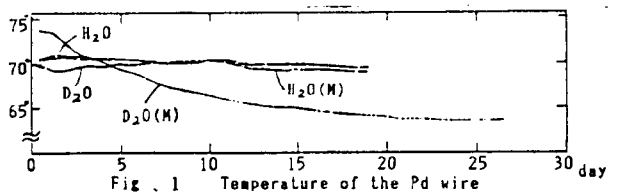


Fig. 1 Temperature of the Pd wire

An ep particle theory
The cold fusion reacts passing next 3 steps.

1) Formation of an ep particle.
e + p→ep. When an electron goes and returns to a H (p) under magnetism, it radiates electro magnetic waves. The e decreases its velocity and enters in the p at last.
2) Growth to an e*p particle ep→e*p. Because an ep particle has very big density (about $3{,}2X10^{15}$ ton/cm^3), it will have very big refraction index (N). Light speed (c/N) inside of it will be so slow as velocity of electrons outside of it. An e of ep will gain speed by collision of electrons and increase its mass according to the relativity theories of Einstein. The decrease of temperature in Fig 1 is on this step.
3) Explosive reaction of e*p particles.
e*p + e*p → D + e + 2.2 Mev. This reaction is
(50%n) (50%n) equivalent to next one.
n + p → D + e + 2.2 Mev
(100%n) (0%n) The electron of 2.2
Mev will shoot the X-ray.

◆ Rare reaction
e*p (50%n) → n.(100%n), n + D → T + r
◆ When impurities (H_2O) is used up, the reaction of heat will stop.

JAPAN - TUNNEL DISINTEGRATION

Toyu Tani and Yukio Kobayashi (The Inst. of Phys. and Chem. Research, Riken, Japan) "Tunnel Disintegration and Neutron Emission Probability," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The tunnel effect in composite systems is discussed, which is essentially different from that in independent-particle systems, and the possibility of a new type of nuclear reaction in condensed matter is indicated on the basis of the "tunnel disintegration".

Cold fusion in condensed matter supported by several researchers seems to be based on the fusion rates of $10^{-64}s^{-1}$ to $10^{-74}s^{-1}$ for two deuterons in a free deuterium molecule. Two deuterons, however, were treated in their calculations as only independent particles in low-energy states. A diatomic molecule is considered to be rigorously stable in quantum mechanics, and thus does not have any probability that the two nuclei penetrate to the region classically forbidden to approach each other to zero separation, keeping the form of a molecule with the electrons. This is derived from the equivalency requirement of the "center-of-mass representation" and the "particle representation" in the whole configuration space. On the other hand, when a diatomic molecule interacts so strongly with a metal such as palladium and tritium that the two nuclei come close together to exceed the classically forbidden region, the "tunnel disintegration" will occur with the transition of the electrons to the continuous states.

The tunnel disintegration of deuterium molecules is considered to happen at the metal surface in the following way: (i) Complete dissociation and saturation. Deuterium molecules adsorbed on the surface will initially be dissociated into atoms by chemical reaction, and this process continues until the metal surface is saturated with the dissociated deuterons. (ii) Tunnel disintegration. After the above saturation, the following deuterium molecules may happen to collapse due to the tunnel disintegration. (iii) Generation of collective modes and localized electric field. In the local region, collective modes ought to be intensively excited around the surface lattices to build up localized electric fields slowly varying in strength.

These localized electric fields will act on the proton in a deuteron, and then nuclear dipole oscillation will be excited between the proton and the neutron in the deuteron due to its loose binding. Therefore the ground state of deuteron is modified by the above fields into a state. When these fields are slowly varying, the amplitudes of dipole oscillations will be gradually increased. This yields a chance of disintegration, since a deuteron has no excited bound states. When the amplitudes attain a maximum, the transition starts to occur from this prepared state to the continuous states and then the neutrons are emitted.

Along this mechanism, we calculated the energy spectrum of emitted s-type neutrons on the assumption that the "far-distance nuclear force" is effective. According to recent experiments, a peak is found at 2.45MeV in the energy spectrum, which is considered to be owing to the d-d nuclear fusion. This peak, however, is explained by this mechanism, and therefore may not be a direct verification of the d-d nuclear fusion. It is shown further that the other main features of so-called cold fusion, that is, (i) poor reproductivity, (ii) high t/n ratio, and (iii) high-energy broad peak, are also explained by this mechanism.

JAPAN - COLD FUSION BURSTS

Ryoichi Taniguchi and Takao Yamamoto (Research Inst. for Adv. Science and Technology, University of Osaka, Japan), "Fine Structure of the Charged Particle Bursts Induced by D_2O Electrolysis," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Internal structures of the cold fusion bursts have been studied by the use of a fast response measurement system.

Nanosecond pulse shapes of the charged particle bursts were obtained.

Charged particles were detected by a NE102a plastic scintillation counter. The detector was set under the bottom of the electrolysis cell and close to a thin palladium-foil cathode. The output current pulses of the photo-multiplier were amplified by a wideband current pulse amplifier, and their wave shapes were recorded in the digital storage oscilloscope. The temperature of the D_2O solution was controlled by a program according to a desired pattern. After the electrolysis at low temperature at 4°C for 6 hours, the cell was warmed up to several ten degrees C. During the warm-up, we caught some anomalous emissions of charged particles and recorded these wave shapes. The current pulse-shapes of the bursts were found not uniform and the pulse width of these bursts had a distribution form 10 to 100 nanosecond. Comparison of these pulse shapes with the standard responses given by a single particle suggested that the burst was not single pulse but the pile-up one consisting of many pulses.

JAPAN - BOSON CLUSTER THEORY

Ken-ichi Tsuchiya (Dept. of Elec. Eng., Tokyo National College of Tech., Tokyo, Japan), Kazutoshi Ohashi (Faculty of Engineering, Tamagawa Univ., Tokyo, Japan) and Mitsuru Fukuchi (Dept. of Instrumentation Eng., Faculty of Science and Technology, Keio Univ., Kanagawa, Japan), "Mechanism of Cold Nuclear Fusion in Palladium," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

A new interpretation of cold nuclear fusion at the center of the boson cluster was given by R.T.Bush et al.[1]. The modified theory is given in this paper by adding the electronic screening effect around deuteron [2]. Tunneling probability is derived by using the screened d-d pair potential [2]. Power of cold nuclear fusion in palladium is obtained, and the role of screening effect is found to be very important.

1) R.T.Bush and R.D.Eagleton, *J. Fusion Energy*, 9(1990)397
2) K.Tsuchiya, Y.H.Ohashi, K.Ohashi and M.Fukuchi, *J.Less-Common Metals*, 172-174(1991)1371

JAPAN - FRACTO-FUSION

K. Watanabe and Y. Fukai (Dept. of Phys., Faculty of Science and Eng., Chuo Univ., Japan) and N. Niimura and O. Konno (Laboratory of Nuclear Science, Faculty of Science, Tohoku Univ., Japan), "A Search For Fracture-Induced Nuclear Fusion In Some Deuterium-Loaded Materials," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Attempts to detect neutron emission attributable to D-D nuclear fusion accompanying fracture of deuterium-loaded materials have been carried out using a ball mill specially designed for this purpose.

Chips (81~500g), loaded with deuterium in a Sieverts-type apparatus, were crushed in the ball mill to about 10μm in size in vacuum or 1atm. of D_2 gas for 60 or 120 minutes. This produced cracks at an average rate of 50~300 cm^2/s. The ball mill was surrounded by polyethylene moderator, in which an array of 4~12 ^3He detectors was located, and the whole assembly was shielded from outside radiation by borated water of 50cm thickness. Signals were counted by CAMAC scalers, and recorded in a micro-computer every 5 min. The signal-counting efficiency was 0.3~4%, and the average background was (0.8~3.0)x10^{-2}n/s. To control the possible acceleration of D+ ions across the cracks, materials of very different mechanical strengths and electrical resistivities were tested.

The foreground to counts observed per minute were 1.8±0.1 for $TiD_{1.0}$, 1.1±0.1 for $TiD_{1.3}$, 1.6±0.1 for $TiD_{1.9}$, 1.8±0.3 for $YD_{2.9}$, 1.3±0.1 and 0.9±0.1 for $Ti_{0.86}Al_{0.1}V_{0.04}D_{1.1}$, 0.8±0.1 cpm for $YBa_2Cu_3O_{7-x}D_{0.8}$, whereas the background counts were 1.27±0.05 cpm.

Thus, in spite of greatly enhanced sensitivities of the experiment to fracture-induced fusion, no positive signature has been obtained for its occurrence.

JAPAN - SPONTANEOUS NEUTRON EMMISSION

Nobuhiko Wada and Toshiaki Goto (Dept. of Physics Faculty, Nagoya Univ., Japan), "Nuclear Fusion in Solid," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

By means of soaking Pd into D_2 gas in a closed vessel spontaneous intermittent neutron emissions are detected reproducibly. [1] The results of controlled experiments for over 30 samples are presented.

The emission efficiency is very much dependent on the preparation of the materials and by means of proper treatment of the sample surface, it is highly promoted as to emit bursts of neutrons. Each sample has respective life time of emissibility of neutron. The exhausted sample materials can be recovered by repreparation of the sample. Exothermic

effect of Pd and D_2 gas relating to the neutron emissions are observed.

Mass spectroanalysis of sealed gas before and after the experiment indicate increase in components of mass numbers 3 and 6 after the experiment. A mechanism of nuclear fusion in solid is proposed. [2]

[1] *Jpn. J. App. Phys.* 28 (1989) pp L2017- L2020
[2] *Tran. Mat. Res. Soc. Jpn.* 2, pp 102-107

JAPAN - FUSION MODEL

Norio Yabuuchi (High Scientific Research Lab., Tsu City, Japan), "Quantum Mechanics on Cold Fusion," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

Deuterium atoms intruding into Pd metal are subject to excitation due to lattice vibration when they are packed among lattices of Pd atoms in the saturated state, which separate electrons away and become deuterons. The deuterons violently vibrate further by receiving excitation due to vibration among lattices of Pd atoms, causing cracks among Pd atoms. Thus an intense electric field appears at the crack, according to Drude's theory, causing the photon field. If so, the field of photon as a Bose particle and that of deuteron as another Bose particle interact to give super-conduction and the deuterons collide with target nucleus resulting in the nuclear fusion.

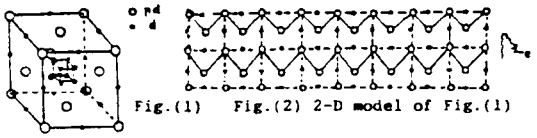


Fig.(1) Fig.(2) 2-D model of Fig.(1)

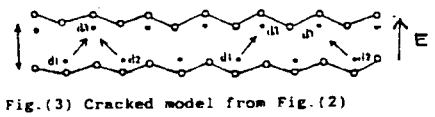


Fig.(3) Cracked model from Fig.(2)

Deuterium atoms intruding into Pd are in the slate as shown in Fig.(1). Illustrated in Fig.(2) is an arbitrary section of Pd metal. Fig.(3) illustrates a state that phenomena turned from ionization to cracking, implying expansion of the Pd metal.

Electric field E created in a crack accelerates deuterons in the crack. In addition, created fields of photons and deuterons interact to cause the phenomenon or superconduction. What illustrates wave phenomenon of the field in the crack of Fig.(3) is Fig.(6), and the physical equation is:

$$|c_1\Psi_{d1}+c_2\Psi_{d2}|^2=|c_1\Psi_{d1}|^3+|c_2\Psi_{d3}|^3+\frac{\bar{c}_1c_2\bar{\Psi}_{d1}\Psi_{d2}+c_1\bar{c}_2\Psi_{d1}\bar{\Psi}_{d2}}{Z\ term}$$

Fig.(4) expresses relationship between probability distribution and amplitude of deuterons. It is 2-body reaction for one d1, and 3-body reaction including the target nucleus for two. Fig.(5) is a wavy expression of the nuclear reaction, and it becomes a reaction of a kind of compound nuclei and the target nucleus in the cases of 3-body reaction.

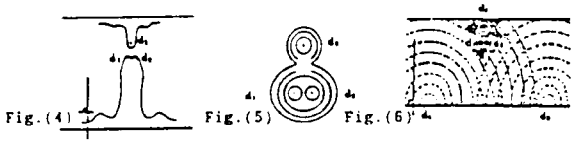


Fig.(4),(5) and (6) illustrate nuclear fusions caused by tunneling effect due to the Z term, respectively.

With increased acceleration, superconduction and large amplitude, the target nucleus d3 and incident d particles, d1 and d2, realize the nuclear fusion through tunneling effect. Therefore, the low temperature nuclear fusion can be expressed with expanded wave equations, as shown in the abstract.

This mixed theory of 2- and 3-body nuclear fusion agreed with experimental value of 2- and 3-body mixture at Osaka University.

In the crack, deuterons give rise to 4 and 5-body reactions simulated by 2- and 3-body reactions, but if the crack becomes wider, the nuclear fusing reaction stops because electric field disappears. When the crack gets narrower by cooling, however, the nuclear fusion takes place again because the electric field reappears. If the overcurrent is caused by on-off control of current in the crack, the nuclear fusion can be promoted.

JAPAN - NON-UNIFORM ELECTRIC FIELD

H. Yamada, N. Sugaya, T. Kamioka, M. Matsukawa, T. Fujiwara and K. Noto (Iwate University, Morioka, Japan), "Neutron Emission from Palladium Electrodes in Deuterium Gas under Highly Non-uniform Electric Field," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The fusion reproducibility in palladium has been searched with the detection of excess neutron for point-to-plane electrode configuration in deuterium and in hydrogen gas using a palladium, nickel and tungsten point. The point electrodes were degassed and annealed at 1173 K for 3 hours, then loaded with deuterium or hydrogen at room temperature for 24 hours.

After this loading, the point electrodes in a closed test cell were kept to be loaded with deuterium or hydrogen under a DC high-voltage application at 0.1 M Pa for 20 up to 40 hours in a low background neutron measuring system. A helium-3 thermal neutron detector was used to determine the patterns of neutron emission over the measurement period of 20 up to 40 hours. The detection efficiency from fission neutron from californium-252 was about 1%. Excess neutron counts were observed using deuterium loaded palladium points under the DC high-voltage application.

To the contrary, no count except background was observed with other points for all the 42 runs under the similar test condition. Three out of twenty deuterium loaded palladium points in deuterium gas have always given considerable neutron counts, although the number of total runs using the three points was five. Furthermore, excess neutron emission was also observed in hydrogen gas using deuterium loaded palladium point, while its counting rate was lower than those in deuterium gas, indicating that fusion did not take place in gas volume but occurred in palladium bulk or on its surface.

The observed highest counting rate of 61 counts for a duration of 10 seconds is about 2,500 times larger than the neutron background counting rate of 8.6 counts per hour. One of the plausible explanations for the more steadily excess counts is that Joule heating of the palladium point due to corona current would stimulate the transport of deuterons from O-site to T-site for the fusion.

JAPAN - FRACTO-FUSION MODEL

K. Yasui (Dept. of Physics, Waseda University, Tokyo, Japan), "Fractofusion Mechanism," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

We have investigated fractofusion mechanism of cold fusion theoretically. We have clarified the conditions necessary for fractofusion during the absorption of D atoms by Pd specimens (the condition of so-called cold fusion experiments). They are crack generations at grain boundaries, high orientation angle of grains, rapid crack formation, increase of electric resistance around a crack, large width of cracks, and many crack generations. We have clarified the origin and the quantity of electric field inside cracks in conductor. By the fractofusion mechanism, we have succeeded to explain qualitatively the experimental facts that neutron emissions are observed in bursts, that sometimes they coincide with deformation of Pd specimen, and that in many experiments excess neutrons were not observed. We have estimated the upper limit of the total fractofusion yields during the absorption of D atoms by Pd specimens. The upper limit of the total yield increases up to $7x10^6$ per $1cm^3$ Pd as the grain size increases to 1mm. The value is larger than those observed in many of the experiments. It indicates that they can be explained by the factofusion mechanism.

JAPAN - TOKYO NEWSPAPER ARTICLE

Courtesy of Jed Rothwell

From the Asahi Shimbun, October 23, 1992.
Translated by Jed Rothwell

Is This Proof Of Cold Fusion?

NTT Announces Detection of Helium-4

October 22, 1992. NTT announced today that it has confirmed that in the cold fusion reaction, pairs of deuterons undergo fusion and combine to form helium-4 atoms. These results come from NTT's unique experiments, with so-called vacuum method cold fusion. Up until now, there have been reports that heavy water electrolysis has caused a cold fusion reaction and generated helium-4, but NTT points out that with the current experiment the system contains no water and no air, so sources of contamination are greatly reduced. Furthermore, the sensitivity of the detection instruments in the NTT experiment is greater than in previous experiments. Details of these results will be reported on the 24th, at the International Conference on Cold Fusion now underway in Nagoya.

Helium-4 was detected by Eiji Yamaguchi (age 37), of the Materials Sciences Division, NTT Basic Research Laboratories. Cold fusion is a phenomenon which occurs at close to room temperature, in which two or more atomic nuclei combine and release energy.

The experiment was performed by coating a 30 mm square by 1 mm thick palladium plate on one side with a thin film oxide, and putting it into a vacuum chamber. The chamber is then filled with deuterium (heavy hydrogen), and the palladium is heated up. After that, the palladium is gradually cooled down. One characteristic of palladium is that it absorbs large amounts of deuterium; this procedure caused the palladium to be saturated with deuterium.

After the palladium plate cooled down, the remaining gas inside of the chamber was pumped out, and the vacuum

restored. A thin film of gold was then applied to the side of the plate that was not covered by the oxide. This sealed in the deuterons. After the palladium was heated once more, helium-4 emissions were detected.

Based upon the amount of helium-4 detected, fusion was occurring inside the palladium plate at a maximum rate of 10^{16} atoms per second, and at the moment the helium-4 was generated, the temperature of the palladium instantaneously rose several hundred degrees. Furthermore, this experiment was repeated five times, and the same result was obtained in all five cases, so it is said to have high reproducibility.

In previous experiments, scientists have looked for neutrons to determine whether or not fusion is occurring, but this time, helium-4 was used as the criterion.

When two electrons fuse, scientists think that one of three reaction products can emerge from the reaction: 1.) helium-3 plus a neutron; 2.) tritium plus hydrogen; 3.) helium-4. In this experiment, a tiny bit of reaction product 2 was found, but NTT thinks that the main reaction that occurred was 3.

Dr. Akito Takahashi, of Osaka University, Dept. Of Engineering (Nuclear Engineering) comments: "If helium-4 was clearly detected, then this experiment is earthshaking. However, we still have not discovered the mechanism of the reaction, so we need additional debate. The likelihood of two deuterons fusing together under normal circumstances is exceedingly small so in order for helium-4 to be generated, we have to assume that three or four new solid state phenomena are coming into play."

KOREA - CREATING TRITIUM

Kew-Ho Lee and Young-Mok Kim (Membrane and Separation Lab., Korea Research Inst. of Chemical Technology, Korea), "The Change Of Tritium Concentration During The Electrolysis Of D_2O In Various Electrolytic Cells," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

This study is to observe the change of tritium (T^3) concentrations, as they can be produced as a nuclear product in palladium metals that were used as cathodes in electrolytic cell of $LiOD/D_2O$ electrolytes.

The U-type electrolytic cells were designed using pyrex glass and modified for recombination of gases with platinum catalysts. Liquid scintillation counter, X-ray BET, ICP and SEM were used to determine T^3 activities of electrolytes and to analyze palladium electrodes. Electrolysis was run at low current density (40-50mA) for a given period and later at high current density for 1-10 days.

The electrolysis of $LiOD/D_2O$ in U-type cell yielded more final activities in Pt/Pd system than Pt/Pt system. Some electrolysis of $LiOD/D_2O$ in Pt/Pd showed the increase of T^3 above 100%. The separation factor of D/T in electrolysis was not measured directly but assumed 2-3 from literature. The increase of T^3 can not be explained with the isotope separation effect. But in the modified cells with recombination, the electrolysis yielded no significant increase of final tritium activities in the total system. In this case, recombined D_2O was collected separately and total T^3 activities were obtained by combining this with residue in D_2O electrolytes.

Finally, bell jar type closed cells were designed with recombination catalysts. And palladium electrode was covered by different porous materials. After 14 days of electrolysis with change of current density one cell showed the increase of T^3 activities significantly.

RUSSIA - CORRELATED DATA

A.Y. Gavrilyuk, P.I. Golubnichy, N.V. Gribinichenko, V.V. Litvinenko, A D. Philonemko, A.A. Tsaric (Lugansk Mech. Eng. Inst., Russia), O.A. Bezsheiko, A.P. Degtyarev, I.B. Mikhnitsk, G.A. Prokopets (Kiev University, Russia) and V.A. Tsarev (Lebedev Physical Inst., Moscow, Russia), "High Efficiency, Low Background Measuring-Computing Complex For Correlation Experiments On The Problem Of Low Temperature Fusion," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

High efficiency low background measuring-computing complex (on line regime) has been created to carry out correlation experiments on the problem of low temperature fusion.

The measuring-computing complex makes possible the search for neutron groups (n>1) and events with "rigid" correlation (within the time limit of 20 microseconds) among pulses of neutron, acoustic and electromagnetic detectors in a time interval 1-256 microseconds.

In real time registration of the moment of appearance of the correlated event and a series of its parameters (time shift of the components, number of pulses in a given period of time in each recording channel) is done with subsequent data recording on magnetic storage device. The maximum "dead" time period is about 1 msec.

The so called "fast-slow" method of neutron registration (fixing the moments of their appearance, deceleration time and capture moments) and in some cases the electronic scheme of division have been used to increase probability of neutron event identification. Both methods permitted to bring up background loadings to $3*10^{-3}$ and 10^{-2} 1/sec with registration efficiency of 8% and 40%.

Checking neutron channels for their normal operation and their calibration have been performed with the help of isotope sources C-252(A=8 1/c) and P4-Be ($A=10^4$ 1/c). The complex has reliable electronic shielding that blocks the computing channels and recording programs at moments of powerful electromagnetic interferences.

The developed mathematical programs provide adequate servicing while collecting statistical data (output and displaying of the necessary parameters on the monitor).

RUSSIA - FRACTO-ACCELERATION MODEL

P.I. Golubnichy, V.V. Litvinenko, A.D. Philonenko, A.A. Tsaric (Lugansk Mech. Eng. Inst., Lugansk, Russia) and Y.A. Artemenko, A.F. Volkov, A.V. Goltsov, V.A. Goltsov (Donetsk Politechnical Inst., Russia) and V.A. Tsarev (Lebedev Physical Institute, Moscow, Russia), "Results Of Correlation Experiments On The Problem of Low Temperature Nuclear Fusion In Some Metal and Intermetal Systems," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The experimental data on search for neutron emission and accompanying acoustic and electromagnetic emission are given for some materials (Pd, NB, LaNi5, steel) at gas and electrolytic saturation of targets with deuterium as well as conditions of nonequilibrium (multiple thermo - cryo cycling).

High efficiency, low background, automatic measuring-computing complex (on line regime) is used to provide simultaneous multi-channel recording of various parameters, including the correlations to determine the presence of neutron groups within the time interval of 1 - 256 microseconds.

The results are discussed from the point of view of fracto-acceleration model of low temperature fusion.

RUSSIA - GLOW-DISCHARGE GAMMAS

A.B. Karabut, Ya.R. Kucherov, I.B. Savvatimova (Lutch Assoc., Moscow Region, Russia), "Gamma-Spectrometry at Glow Discharge in Deuterium," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Spectrometry of gamma-emission from glow discharge in deuterium with Palladium, Niobium, Zirconium and other cathodes was made. We used up to four computerized measuring channels with different detectors, such as Ge-Li, stilbenum, NaI and SPS plastic. The measuring range was up to 10 MeV. X-ray films with Al, Fe and Pb screens were also used inside and outside the discharge chamber [1]. In our previous publication [2] we noted the formation of short-living gamma-radioactive isotopes on the cathode and the anode with the change from the initial material as Z=1 (Z-is the nuclear charge of the corresponding element). In our recent experiments we saw characteristic X-rays (5-20 KeV) and gamma-lines of short-living isotopes with up to Z+3 and Z+8. The intensity of some of the gamma-lines was 10^2 - $10^5 s^{-1}$. Gamma-emission lasts about 1 hour after the discharge switch-off. The intensity in 5 MeV range (n-gamma and d-p reactions) is small. For 120-200 KeV energy range high intensity beams of gamma-quants with anisotropy over the 4π solid angle can be seen. Beam divergence is less than 0,1 degree. The existence of these beams can affect the accuracy of the spectroscopic measurements.

[1]. Karabut A.B., Kucherov Ya.R., Savvatimova I.B., "Nuclear Reaction at Gas Discharge Cathode," *Sov. Techn. Phys. Letters*, v. 16, iss. 12, 1990, p. 53-57.

[2]. Karabut A.B., Kucherov Ya.R., Savvatimova I.B., "The Investigation of Deuterium Nuclei Fusion At Glow Discharge Cathode," *Trans. Fusion Technology*, v.20, No 4, part 2, 1991, p.924-928.

RUSSIA - GLOW-DISCHARGE TRITIUM

V.A. Romodanov, V.I. Savin, Yu.M. Timofeev (Moscow Region, RI of SPA LUTCH, Russia), "Reactions Of Nuclear Fusion In Condensed Media." Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

It is possible to solve the problem of so-called "cold" fusion only by extending and deepening the investigations. We have done this using powerful glow discharge for such investigations for the first time [1,2]

On the basis of the analysis of the energy loss by a fast particle in a solid it is supposed that the most probable

energy range for the reactions of nuclear fusion in condensed media is in the range of the reduced energy of the interaction particles from E_O to E_2 (~(2-400)·1.6·10^{-19} J for D-D reactions).

The dependence of the rate of the reactions of nuclear fusion in condensed media on the ionic bombardment parameters, when the accelerated deuterium ions from the glow discharge plasma interact with different elements, has, been determined.

The tritium generation rate has increased by four orders of magnitude, while increasing the specific power by a factor of four, and it has reached the value of 10^9 atoms^{-1} when the neutron-to-tritium yield ratio is in the range from 10^{-7} to 10^{-9}. The ions having the energy (20-80)·1.6·10^{-19} J were used in the experiments.

The possibility of performing the reactions of nuclear fusion in condensed media between deuterium and target atoms at low energies is shown on the basis of the thermal effect measurements, the isotopic target composition change and the radiography results.

1. V.A. Romodanov, V.I. Savin, M.V. Shakhurin, V.T. Chernyavsky, A.E. Pustovit. "Nuclear Fusion in a Solid." International Conference on Radiative Material Science the USSR, Alushta, May 22-25, 1990. Poster report 1-100. Kharkov, 1990. 1-85, Part II, p.80, (in Russian).
2. V.A. Romodanov, V.I. Savin, M.V. Shakhurin, V.T. Chernyavsky, A.E. Pustovit, "Nuclear Fusion in a Solid," Zhurnal tekhnicheskoy Fiziki, 1991, v. 61, p.122-125 (in Russian).

RUSSIA - FRACTO-FUSION RESULTS

P.I. Golubnichy, A.D. Philonenko, A.A. Tsaric, E.E. Shimko (Lugansk Mech. Eng. Inst., Russia), V.F. Zelensky, V. F. Rybalko (Kharkov Physical Tech. Inst., Russia), V.A. Tsarev (Lebedev Physical Inst., Moscow, Russia), "Search for Neutron Emission at Impact Destruction of Deuterides Li, Ti and Some Deuterium Carrying Crystal Hydrates," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

The impact destruction of crystal LiD (Σm=10g), tablets TiDx (x=1; x=2; Σm=40g) and crystals $Al_2(SO_4)3K_2SO_4$*$24D_2O$ (Σm=15g) was performed to determine the neutron emission intensity at juvenile surface creation in some deuterium carrying materials. Degree of dispersion of the end product at destruction reached 0.5 - 2 m**2/g.

The recording devices sensitivity and improved background conditions (the so called "fast-slow" method of neutron registration was used) permitted to detect neutron fluxes one hundred times less intensive than in [1,2].

The obtained results were discussed taking into account different versions of fracto-acceleration model of low temperature nuclear fusion, including its plasma and gas dynamic modification [3,4,5].

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RUSSIA - GLOW-DISCHARGE PARTICLES

A.B. Karabut, Ya.R. Kucherov, I.B. Savvatimova (Lutch Association, Podolsk, Russia) and A.D. Kurepin (Moscow Physico-Engineering Inst., Moscow, Russia), "Heavy Charged Particle Registration At Glow Discharge In Deuterium," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

A vacuum chamber with 1 cm^2 beryllium window was used in our experiments. The chamber and experimental regimes are described in [1]. Silicon surface barrier detectors with various thickness were used for charged particles registration. The detectors were placed outside the vacuum chamber over the Be-window. Detector efficiency in used geometry was about 10^{-5}. Alpha-particles from U^{235} and Pu^{239} isotopes were used for detectors calibration.

Three peaks with energy 6±0.5 MeV, 12±1 MeV and 16±1.5 MeV were registered. The maximal energy of charged particles was 18±2 MeV. Using detectors with various thickness allows us to say that for energy > 12 MeV it can only be charged particles with A≥4. Specific intensity calculated as on-cathode point source is ~l04s^{-1} for 12 and 16 MeV peaks and more than 10^6s^{-1} for 6 MeV peak. The

spectral composition of particle emission does not change for about 5 minutes after the discharge switch-off.

Alpha-particles flow registration with calibrated CR-39 (cellulose nitrate) plates installed inside the discharge chamber correlated with silicon detectors results. High resolution mass-spectrometry showed a few orders increase in He^4 concentration in cathode samples. So, alpha-particles are the products of nuclear reaction at glow discharge.

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SPAIN - TITANIUM CATHODES

J. Sevilla, B. Escarpizo, F.J. Fernández, F. Cuevas and C. Sánchez (Dpto. Física de Materiales C-IV, Universidad Autónoma de Madrid, Spain), "Time-Evolution Of Tritium Concentration In The Electrolyte Of Prolonged Cold Fusion Experiments And Its Relation To The Ti Cathode Surface Treatment," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Wide discussion is currently established to elucidate whether cold fusion experiments with open or closed cells must be accomplished. When open cells are used some Tritium goes out from the cells with the produced gases and vapors and therefore some difficulties may appear on determining possible increases of its concentration.

We have faced this problem through more than twenty electrolytic cold fusion experiments accomplished with open cells and Ti or Pd cathodes. In all of them the time evolution of the T concentration in the electrolyte was carefully monitored. In order to distinguish between T-natural enrichment (isotopic enrichment) due to electrolysis and any other source of T inside the cell, a macroscopic theoretical model is proposed to fit the experimental data. It is concluded that T-concentration variations in the electrolyte over the background levels (determined by natural enrichment) can be detected with confidence and therefore open cell experiments can be considered as convenient to investigate T production.

In addition some empirical correlations between model parameters (observed separation factors) and the surface treatments of the cathodes prior to experiment have been found. This finding has allowed us to classify the cold fusion experiments in groups and categories.

SWITZERLAND - QUADROPOLE COUPLING

Rolf Eggenberger, Stefan Gerber, Hanspeter Huber, Debra Searles, and Marc Welker (Institut fur Physikalische Chemie der Universität Basel, Switzerland) "Ab Initio Calculation Of The Deuterium Quadrupole Coupling In Liquid Water," *J. Chem. Phys.*, 97,(8), Oct. 15, 1992, pp 5898-5904.

AUTHORS' ABSTRACT

The quadrupole coupling constant and asymmetry parameter for the deuteron in liquid heavy water was determined using purely theoretical methods. Molecular-dynamics simulations with the *ab initio* potential-energy surface of Lie and Clementi were used to generate snapshots of the liquid. The electric-field gradient at the deuteron was then calculated for these configurations and averaged to obtain the liquid quadrupole coupling constant. At 300 K a quadrupole coupling constant of 256 ± 5 Khz and an asymmetry parameter of 0.164 ± 0.003 were obtained. The temperature dependence of the quadrupole coupling constant was investigated.

TAIWAN - Pd MICROSTRUCTURES

C.L. Hsu, C.M. Wan and F.-R. Chen (Materials Science Center, Nat. Tsing-Hua University, Taiwan), "Transmission Electron Microscopy of Palladium Electrodes in Electrochemical Systems," presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

More than three years ago, thousands of scientists around the world raced to confirm the claims of electrochemically induced fusion especially in the palladium/deuterium system in which case hydrogen or deuterium absorption may be crucial and probably depends strongly on the microstructure of palladium. [1,2] However, since then, only little attention was received in the correlation of microstructural alteration of palladium electrodes with heat generation or other fusion-related phenomena. [3] Since transmission electron microscope can provide a detailed assessment of defects, such as dislocations and stacking faults, and grain structure in palladium electrodes, we have recently carried out systematic transmission electron microscopy studies of microstructural evolution of palladium electrodes in both heavy water and molten salt electrolyte. JEOL 200CX and 4000EX microscopes were used for this study.

Preliminary results were obtained. In an annealed palladium electrode, only a few dislocations were observed. However, cold work-like dislocation tangling and subgrain boundaries were found in a palladium electrode in molten salt system

and high density of stacking faults were observed in a palladium electrode/heavy water system. Although the electron microscope cannot decide the cold fusion issue, the microstructural details at both μm and the atomic scale level might provide useful perspective information on the role of microstructures in altering deuterium absorption and concentration.

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TAIWAN - HEAT BURSTS

C.M. Wan, C.J. Linn, C.DY. Liang, S.K. Chen, C.C. Wan, and T.P. Perng (Materials Science Center, National Tsing Hua Univ., Taiwan), "Repeated Heat Bursts In The Electrolysis Of D_2O," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

An annealed palladium rod in a diameter of 3mm was used for electrolysis of D_2O. The cell with about 400ml of electrolyte was immersed in a 20-liter thermally insulated water tank. The charging current densities were increased in steps from less than 0.1 to 1.2 A/cm^2. During the electrolysis, the cell temperature occasionally showed some abnormal fluctuation, but the fluctuation was always insignificant, less than 0.5°C. After 7 weeks of continuous charging, the experiment was stopped, and both Pd cathode and Pt anode were removed from the cell. The Pd electrode was immersed in HNO_3 solution to get a cleaner surface. After 40 minutes of interruption of the experiment, both electrodes were put back to the cell assembly and the electrolysis was resumed. A series of cell temperature bursts, ranging from 1.0 to 2.5°C were observed in the subsequent charging. The first burst occurred at about 90 minutes after the restart of the experiment. Similar events repeated every several hours. The magnitudes of the bursts increased with the charging current. A burst of 2.5°C was observed for the current of 1.85 A/cm^2. It is postulated that the interruption of the experiment and the partial outgassing of deuterium from the Pd electrode could be critical to the repeated occurrence of the bursts. More experiments are now undertaken to examine the effects of these factors.

TAIWAN - ANOMALIES WITH Pd

C.M. Wan, S.K. Chen, C.Y. Liang (Materials Science Center, National Tsing Hua University, Taiwan) and C.J. Linn, C.C. Wan (Dept. of Chem. Eng., National Tsing Hua Univ., Taiwan). "Anomalous Heat Production/Absorption In Pd/D_2O (LiOD)/Pd System," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

An anomalous heat production phenomenon has been observed in Pd/D_2O (LiD)/Pt system at 25°C since it was announced in 1989. In repeating the experiment a Pt film of more than 400 Angstrom in thickness was occasionally observed by the profiling technique in Auger Electron Spectroscopy from a Pd sample charged in electrolyte. Since the deuterium solubility in Pt is several orders less than that in Pd, the Pd/D_2O (LiOD)/Pd system was therefore chosen for the experiment.

As Arata and Zhang's results for the higher temperature operation at 80°C was considered [1], the Pd/d_2O (LiOD)/Pd system at about 80°C was used to check both the effects of the anodic material and the temperature.

An excess heat burst from 85.5 to 101.4°C for about 90 min. was once observed after a cell had been run for 48 hours with a background temperature at 85.4°C in the Pd/D_2O (0.1m LiOD)/Pd system. At the onset of the excess power produced in the Pd cathode, bath temperature maintained by a NESLAB Refrigerator/Circulator showed a small temperature decrease, which seemed to intend to compensate the heat burst by the excess power production. An anomalous heat absorption was observed once about every 10 hrs. after the production of excess power and had lasted for weeks. In this heat absorption the cell temperature dropped from 90°C to below the background temperature only within several minutes.

When the cell temperature was higher than 90°C, a silicate film was observed on the Pd surface which is thought to be harmful to the deuterium charging for the Pd cathode.

[1] Y. Arata and Y. C. Zhang, *Fusion Technnol.,* Fusion Technol., 18, (1990) 95.

E. SHORT ARTICLES FROM READERS

The Silica Effect In D_2O Electrode Calorimetry
And In H_2O On Nickel
by Ernest E. Criddle, Electrochemical Science and Technology Centre, University of Ottawa

Electrode calorimetry demonstrated that a Pt anode is four times hotter than a comparable sized Pd cathode in 0.3N LiOD at any current. The effect lasted for a month (1,2). A second run was cut short by quite anomalous behavior: gas bubbles entered the Luggins capillaries of each reference

electrode and deposited silica in those references. The effect of silica gel at electrodes was further investigated at Ni cathodes in 0.57M K_2CO_3 by adding silica to the electrolyte and to the electrodes. With this alteration in procedure, excess heat from ordinary water was frequently observed. Without the silica addition heat was normally absent.

Electrode Calorimetry

The calorimetry experiment used 1.4cm^2 Electrodes with a thermocouple well behind each which was potted to the back of the electrode with polyester resin. Thus, the thermocouple was insulated from the solution and observed the temperature of its electrode. The performance of each half cell was observed with a Hg/HgO reference electrode; each had a Luggin capillary to eliminate solution resistance from the results. The product of half cell potential (corrected for gas evolution) and cell current provided the power input to that electrode. The temperature of the half cells provided a reasonable comparison of the two electrodes. Not surprisingly, the notoriously inefficient oxygen evolution process produced much more heat than hydrogen evolution.

At the end of a month of electrolysis were cleaned by polishing with 400 grit paper. A second run with the same cell used 0.3N LiOD which had been freshly prepared from Li metal dissolved in D_2O. A plot of heating vs input for the second run was not smooth. The experiment was abandoned at the end of seven days due to instabilities in half cell voltages.

A post mortem examination of the cell found that the Luggin capillary next to the cathode was blocked with an almost clear crystalline substance and both reference electrode tubes had white scale in their tubes which did not dissolve in acid, This was deemed to be silica deposit which was easily removed with sodium bicarbonate on a pipe cleaner.

Comparison of data from the two runs revealed that anode voltages in the first run fluctuated by 0.4 V on the first day. This fluctuation decreased to 0.1 V by the 26th day. In the second run, the anode fluctuations started at 0.6V and increased to 1.1 V by the seventh say. Cathode voltages were more stable. Cell voltages were always constant (±0.03V) in both runs. In the second run, voltage fluctuations were observed to coincide with bubbles which moved into the reference electrodes. The Flow of bubbles increased as second run progressed. The difference appeared to stem from the fresh LiOD used in the second run.

Nickel In Light-Water

Reports of greater excess heat from nickel in ordinary water led to the preparation of a nickel electrode calorimeter. The question of how to guarantee that excess heat was produced in the cell demanded careful evaluation (3,4). Thus, techniques were tested for the production of excess heat. None was found on 2.7cm^2 of 2mm diameter nickel rod until 100ppm SiO_2 was added when results became sporadic (not so positive as McKubre's pixie dust in LiOD). None was found on nickel foil until 100ppm SiO_2 was added to the 0.57M K_2CO_3 and the electrode was provided with a coat of silica. Thereafter, excess heats to double the calibration heating were frequently observed. Specifically, cells with calibrations constants of 10°C/watt provided close to 20°C/watt during electrolysis.

Analysis by ICP showed that our lab distilled water contains 0.01ppm silica. The Fisher Scientific K_2CO_3 is labelled as 0.001% silica (7.9ppm in 0.57 M solution) but fresh 0.57M K_2CO_3 solution was analyzed as containing 70.37ppm. The K_2CO_3 powder was found to contain no boron but the "fresh" 0.57M K_2 CO_3 solution contained 0.51ppm boron; presumably the Pyrex flask had dissolved to increase boron and provide 70.37ppm silica instead of 7.9ppm. When enough 1.2M KOH/SiO_2 was added to increase the solution by 100ppm silica, the analysis found 110.16ppm silica in used cell electrolyte. The balance had either precipitated or coagulated on the Pyrex cell and electrodes.

Isothermal calibration tests were conducted by turning off the cell current, turning on the calibration heater and adjusting it to hold the cell temperature constant for at least half an hour. The 75mi Dewar cell with 60mi solution often calibrated at 10°C/watt of heating. During a run with excess heat the calibration constant rose to 14°C/watt. When the cell was operated in reverse with the nickel anodic (and likely to stick anodic silica on its oxide surface) the cell constant fell to 8.4°C/watt. After prolonged operation, the cell calibration constant and normal heat output from electrolysis averaged about 11°C/watt. This was readily returned to 10°C/watt by brushing the cell with wet sodium bicarbonate and returning the electrolyte and cell electrode assembly to the cell.

Higher heating was often observed when the cell was operated in reverse at 0.07mA/cm^2 for 24 hours or when the cathode was replaced with nickel which had been polished, degreased, dipped in 20% sodium metasilicate (with or without current), and dried. Lower excess heating resulted in another series of experiments after 10ppm $FeCi_3$ was added to silica before K_2CO_3 was added; Fe^{3+} absorbs silica and carries it to the cathode.

It is difficult to explain "variable constants" in a manner that satisfies physicists, chemists and mathematicians. My hypothesis pictures a very high light silica gel formed electrophoretically near silica-coated electrodes (but held separate from them by VanDerWall's forces). The gel them migrates by thermophoresis to the cell wall and increases its thermal resistance. This is removed by brushing with wet sodium bicarbonate or by reversing the cell and scavenging silica with the anodic nickel.

It is postulated that phase changes in silica produce fusion products including heat in cold fusion cells in much the same way that phase changes in silicate rocks may give rise to the fusion products observed in fumaroles and volcanoes (5,6). Phase changes in palladium (7) and in titanium (8) produce fusion products when they undergo phase changes in the presence of deuterium; why not silica?

Once crystallized, the silica forms a very small amount of white residue which appeared in the aged electrolyte of the first electrode calorimetry run. In the fresh LiOD of the second run, smaller particles and molecules formed silica gels which trapped gas bubbles and forced them into the Luggin capillaries.

In 0.57M K_2CO_3 with 100ppm silica added, the Teflon covered stirring bar in the operating cell became coated with bubbles up to 3mm in diameter while the stirring bar in the dummy cell as described elsewhere (3,4) remained clear of bubbles. Presumably, silica gel, formed by electrophoresis in the operation cell, held these bubbles to the stirring bar; they were not detached by rotation.

In conclusion, it is recognized that silica may play a role in producing excess heat. It is almost certainly responsible for changing the rate at which heat escapes from some cells. Work continues to evaluate the effects of silica on both excess heating and changing cell constants.

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Deuteron-Proton Hypothesis

by H. Aspden, Acres High, Southampton, England

A question which needs to be addressed and which bears upon the 'cold fusion' issue is whether the observed natural abundance ratio of the first and second isotopes of hydrogen is a progressively degenerating quantity or whether it is a fundamental constant governed by equilibrium criteria. One must wonder why the ratio found in cometary matter is the same as that found in our oceans, if there is not some regulating two-way process at work.

In this brief communication I report that my analysis has led to the derivation of the proton/deuteron ratio as being given by the factor:

$$9(16/7)^8$$

which corresponds to 1491 deuterons per ten million protons.

This compares with the empirically reported value of 1492 deuterons per ten million protons as listed in the 2nd Edition of Condon & Odishaw's 'Handbook of Physics' (McGraw-Hill) at page 9-65.

The theory is based on recognizing that both the deuteron and the proton have transiently changing 'quark-like' states involving vacuum energy fluctuation and focusing attention on transition possibilities between states at constant energy for the proton to deuteron transition and states excited by a 0.511 MeV (single positron annihilation) input for the deuteron to proton transition. A full report on this analysis is available upon enquiry to the author, but it may be of interest here to comment briefly on the implications.

The equilibrium process appears to have an action time which, in theory, is about 10 hours, meaning that, subject to there being adequate external exchange of electric charge to conserve parity and of oxygen if on is concerned with equilibrium in the heavy-water/normal water medium, any forced initial imbalance of the mix will adjust to equilibrium at that time rate.

One immediately sees that the very dominance of the proton in the equilibrium state means that there is very little energy action in unit volume of hydrogen oxide normalizing, whereas deuterium oxide would be more effective in energy action by a factor measured in thousands.

Further one sees reason why deuterium absorbed into a metal host having an electric potential might experience enhanced activity, inasmuch as charge is needed to assure polarity conservation.

The reaction: deuteron + e^+ = proton + proton may seem to be impossible by standard physics teachings, but one must be open to a new science involving energy exchanges with the zero-point energy field. Such exchanges will normally be fluctuations without any net exchange of energy, but under certain very special circumstances, where stable particle forms are involved as alternative products, a reaction at constant energy for one combination of states may lock the products into their stable forms. Then, there could be a consequential one-way net energy transfer resulting either in anomalous heating or anomalous cooling.

The deuteron in its highest energy transient state will have 'borrowed' energy transiently from the zero-point field background. If it produces protons whilst in that elevated energy condition, then that field background will suffer a

deficit condition. The vacuum of space through which we move at cosmic speed might be cooled, drawing on its 2.7K energy reserves, but that charge e+ associated with the energy 0.511 MeV is local and it will shed its energy as heat which should manifest itself in our experimental observations. That is, unless the reverse process occurs as well (the normal state of affairs) and two protons fuse to produce a deuteron and draw on energy to materialize a positron as a way of keeping charge parity.

Readers may remember an earlier contribution of mine in which I drew attention to that significance of the magnetic moment as an indicator that the deuteron has a neutral core state for 1/7th of the time. This is its highest energy state and the factor 7 in the above formulation is there because it expresses the likelihood of the transition process occurring in the way described. That neutral core state also makes it vulnerable to nuclear change.

One can understand why heavy water stored in a bottle will not change to normal water, because, apart from the necessary oxygen intake, the electric charge is not available. The surplus charge activity, characteristic of oscillations of electric potential, is not present, as it can be in the charged electrodes used in electrolytic processes. One can also see for being more attentive to claims concerning anomalies in experiments in which electricity is fed through water, not to mention electrical effects on our body fluids.

In summary, it is hoped that readers will consider the implications of what is said above. The processes occurring in cold fusion may well relate to the ease with which electric charge (as opposed to current as such) can feed the fusion reaction, which otherwise would be starved on account of the parity factor. Energy release from such 'cold' nuclear transmutation of deuterons should involve activity spread over many hours or days. Indeed, what is suggested is based on probabilities that should not escalate explosively, because the regulation is governed by the constant rhythm and uniformity of the vacuum field background. Finally, while there are undoubtedly reactions involving deuteron 'cold fusion', one may begin to wonder from what is said above whether there is also a process of 'cold fission'!

F. LETTERS TO THE EDITOR

U.S. - SCIENTIFIC HARASSMENT SPREADS
By Jed Rothwell

Here is a reminder that cold fusion is not the only field of science where pathological idiots from the establishment call the shots, harass people, and prevent honest researchers from doing important work. This is from a review of the book The Invisible Epidemic, in the N.Y. Times Book Review, 11/29/92.

The reason women with AIDS have been virtually invisible... is that the medical establishment has persistently refused to recognize that AIDS in women does not look like AIDS in men. As early as 1983, a number of female doctors and other health workers... began to notice a strong link between severe, recurring gynecological abnormalities and presence of H.I.V... But when they submitted research proposals to investigate this connection... both government and private funding agencies repeatedly turned them down. And when the doctors conducted the research in their own time, medical journals and scientific conferences consistently rejected their papers."

"Sometimes this official chorus of 'nos' has reflected mere lack of interest, at other times hostility. Ms. Corea (author) reports that Judith Cohen, an epidemiologist at the school of Public Health at the University of California, Berkeley, was told by the chairman of her department that if she continued to waste time studying AIDS in women, 'she had better find another job.'"

LETTER FROM CALIFORNIA
from Joe Guokas

Dear Hal,

The success of the new hydrogen-alkali cell (led by R.Mills, V.C. Noninski, R.T. Bush and R. D. Eagleton) is remarkable. The transmutations observed by Bush (as well as those by Mutsumoto, Rollison, BARC, and others) suggest that in cold fusion the Coulomb barrier does not prevent reactions even with high-Z atoms.

If this is true, cold fusion could cause serious problems for nuclear non-proliferation. When cold fusion is understood well enough to optimize the reactions, we are likely to find strong reactions with many of the hundreds of isotopes available, not just hydrogen isotopes. If any one of these reactions releases neutrons, it could be used to breed fissionable material.

Either of these breeder reactions could be used: b- = beta decay

```
                        b-          b-
U(238) (n,gamma) U(239)-------> Np(239)-------> Pu(239)
                        b-          b-
Th(232) (n,gamma) Th(233)------> Pa(233)-------> U(233)
```

Note that U(238) is available in DEPLETED uranium. Thorium 232 is commonly used in picture tubes and gas lantern mantles. This was of no concern in the past, because they could be made fissionable only by processing in a nuclear reactor. No one anticipated that a reactor could be built from water, a jam jar, and two wires.

Cold Fusion experiments are becoming reliable enough to get clear data. So it is likely that this year someone will solve the mystery of cold fusion. What should he do? He could publish. He could seek funding for the complicated development and patenting to follow up the breakthrough. But then only after many people are involved in the development will the experiments that breed fissionable material be found. Then it will be too late to prevent its spread.

It would be far less destabilizing if a U.S. national lab could review any proposed explanation for cold fusion at its early stages. If it proves true, the lab has the resources to quickly try the many possible reactions to see if any are dangerous. To encourage researchers to share breakthroughs with national labs at the early stages, there should be a way to guarantee rights to the subsequent developments.

Those of us who have looked at the evidence know cold fusion is real. Knowing this, we are responsible for planning the proper use of cold fusion. If you or your readers have suggestions how this can be done, this could be a big help. For once, the implications of a major invention would be anticipated and prepared for in advance.

Sincerely, Joe Goukas

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