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

VOLUME 4 NUMBER 5 FUSION FACTS NOVEMBER 1992

CONTENTS FOR NOVEMBER 1992

LECTURE NOTICE

Friday, December 3, 1992
Demonstrations Thursday and Friday
M.I.T. Electrical Engineering Department
Building 34, Room 34-401 A, the Greer Room

EXCESS HEAT PRODUCTION IN ELECTROLYSIS OF POTASSIUM CARBONATE SOLUTION WITH NICKEL ELECTRODES by Reiko Notoya
of the Catalysis Research Center,
Hokkaido National University, Japan

Dr. Notoya will give a lecture and a demonstration of a light-water, nickel cold fusion device, which generates 3 to 4 times more heat energy than the electrical energy put into it. It is shown in a side-by-side comparison with a resistance heater control cell: upon equal power input, the cold fusion cell becomes about 15°C hotter than the control cell.

For information call Jed Rothwell, Cold Fusion Research Advocates, (404) 451-9890.

A. NAGOYA CONFERENCE - GENERAL COMMENTS

By Hal Fox, Editor-in-Chief

Fusion Facts was pleased to be in attendance at The Third International Conference on Cold Fusion which was held at the Nagoya Congress Center in Nagoya, Japan, October 21 through 25, 1992. There were over 300 attendees at the conference with about 200 from Japan, 55 from U.S. and the rest as follows: Canada - 2; China - 11; France - 5; Germany - 2; India - 1; Italy - 20; Korea - 1; Republic of China - 4; Russia - 14, Spain - 2; Switzerland - 1; and United Kingdom - 1. Except for Italy, Japan, Russia, and the U.S., none of the major users of nuclear power were well represented at the conference.

One of the French scientists related that he had been working under French government funds in his early cold fusion experiments. As he obtained positive results the funding oversight group got nervous and cut off his funds. It appears that France has made a major commitment to nuclear fission power with contracts committed into the next century. Successful cold fusion is apparently viewed as a threat to the energy plans of the current French government. This report confirms our suspicions that the cold fusion is deemed as a threat to the status quo (both fission and hot fusion) of the existing administrative and scientific structure of some of the world's leading industrial countries, including the U.S.

The many positive papers at this Nagoya conference demonstrates again that the phenomena collectively known as cold fusion is a new science; that the experimental results are not fully understood; and that the science is approaching commercialization. It is unfortunate that when this world needs low-cost, environmentally-benign energy, the entrenched political and scientific bureaucracies are intent on the preservation of the current polluting energy sources.

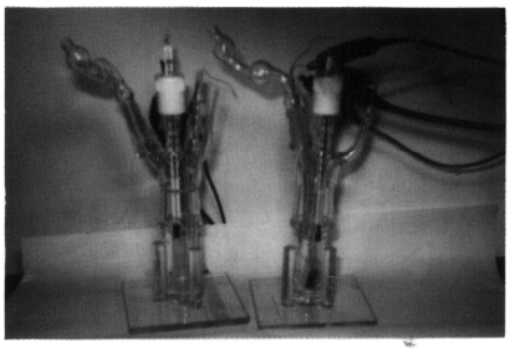
In our attempt to **forecast** some of the highlights of the Nagoya Conference, (*Fusion Facts* October, 1992, pages 1-2) we had some hits and some surprises. Fleischmann and Pons did show some exciting videos of electrochemical cells "turning on" the palladium-alloy cathodes to high temperatures and completely

boiling off the electrolyte in four cells. There were some reports of replication of the Takahashi work. One Japanese and one Indian paper reported on successes using light-water, nickel-cathode, electrochemical cells. It was strange that the two scientists (Bush and Eagleton) who were responsible for triggering the efforts in both Hokkaido and India received little mention. Dr. Bush had sent early preprints of his paper to both groups. [see *Fusion Facts*, December 1991, page 1, for abstract of Dr. Bush's paper that was later published in *Fusion Technology* in September, 1992.]

One of the "misses" in our forecast was that Dr. Peter Glück was unable to get to the conference and present his paper on nuclear catalysis. However, there were other significant developments reported in modeling and in theory. Dr. Peter Hagelstein stated that he considered his work in developing a theory of cold fusion from fundamental principles the highlight of his professional career. That statement, coming from the scientist who is credited with the invention of the X-ray laser, is impressive.

Among the welcomed surprises at the conference were the following:

1. Dr. Reiko Notoya of Hokkaido University had two light-water cells running on a table in the foyer to the conference. One cell was operating by Joule heating and the second identical cell was producing excess heat using the same amount of input electrical energy and using light-water/potassium-carbonate electrolyte and a nickel cathode. Installed thermometers in the two cells showed dramatic temperature differences. The cells were turned "ON" and "OFF" and continued operation for each of the several days of the conference.



2. Papers presented by Karabut and Kucherov of "Lutch", Podolsk, Russia where it was reported that 500% excess heat was achieved using "glow-discharge" pressure level of deuterium gas, palladium cathode, and a few hundred volts.

3. The Russian work by Kabir Kaliev using "bronze" crystals. These porous crystals apparently support some type of cold-fusion effect that is reported to be highly replicatable. This work came from the Institute of High-Temperature Electrochemistry, Ural Division of Academy of Science of Russia, in Ekaterinburg (formerly Sverdlovsk).

4. One of the most interesting events associated with the conference was the announcement to the press in Tokyo by Nippon Telephone and Telegraph (NTT) of the work by Dr. Yamaguchi in which thin palladium plates are loaded with deuterium and then "triggered" under vacuum conditions to produce heat. The announcement resulted in media articles which then resulted in NTT stock increasing about 10% in share price. The London financial community wondered what could possibly cause NTT stock to rise so dramatically, therefore arrangements were made for a Reuters' correspondent to visit the conference. It was reported (but not yet verified by us) that a London financial paper suggested that, "We should have been in cold fusion since its discovery."

We did predict that this Nagoya conference would likely become the media **turning-point** for the gradual recognition of cold fusion as a new science. We are now convinced that such media acceptance is now underway. See the latest report from the New York Times reported herein.

We commend Dr. Ikegami and his Japanese staff and his international conference committee. They provided the attendees with the largest cold fusion conference yet held. Our special thanks to all of you.

Although the conference was a great success, we have the following suggestions for the next cold fusion conference:

1. The proper presentation of the best technical papers is more important than other activities (such as visiting factories.)

2. More effort should be expended to have the printing on transparencies (for overhead projectors) large enough that it can be read by the audience. Many of the speakers could not be understood. This communication difficulty combined with projections that could not be read caused a failure in communication of important scientific data.

3. The media is important to spreading the word about cold fusion. The media should not be treated as second-class visitors.

4. There should be more emphasis given to the selection of quality papers for oral presentation rather than to geography or academic politics.

5. The size of the conference is now large enough that concurrent sessions should be planned.

6. All oral sessions should be video-taped and the presentations made available together with copies of the transparencies used. If possible, highlights of the poster sessions should be taped.

7. In this day of desk-top publishing and high-speed copying machines, it is conceivable that papers could be published in time to provide copies for the attendees at the conference. Or at least, a multi-page summary with important figures, tables, and/or equations could be reproduced before or during the conference.

8. The location of conferences should be selected with some consideration given to the costs to the attendees.

B. BANQUET ADDRESS - NAGOYA 3ICCF
Courtesy of Jed Rothwell, Clustron Sciences Corp.

This speech was delivered by Minoru Toyoda during the Banquet for the Third Annual Conference on Cold Fusion in Nagoya, Japan, on October 23, 1992. Mr. Toyoda was born August 3, 1913. He is a senior member of the Toyoda family, the founders and principal owners of the Toyota Motor Company. At present he is Honorary Advisor to all of the Aisin family industries (Toyota subsidiaries), including Technova, Inc.

My name is Minoru Toyoda, and I am the Honorary Chairman of Technova, Incorporated.

I was invited by Professor Ikegami, Chairman of the Committee of this International Conference, to the dinner tonight, but because of a slight problem with my health, the doctor has advised me to excuse myself from official functions. I sincerely regret that I will not be able to enjoy meeting and conversing with all of you. I have asked Mr. Kyotani, Chairman of Technova to kindly read this message expressing my convictions, on my behalf.

I am delighted that the Third International Conference on Cold Fusion is being held on such a grand scale here in the city of Nagoya, Japan. I am pleased to welcome eminent cold fusion researchers from all over the world. It is my fondest hope that you will be able to exchange ideas and information in spirited, open, and productive debates.

For a long time, I have held the strong belief that equitable growth in the world economy during the 21st century will only be achieved by the harmonious development of science and technology, through international cooperation.

To make this belief a reality, I established Technova in Tokyo in May 1978, as an organization that would have complete freedom to participate in the international forum of research. During the fourteen years since its inception, in the ever-changing world of international research, we have made steady progress, thanks to the help of some of the best minds in the world. Technova has been very active in the development and application of advanced technology, and in adapting advanced technology to practical uses. We have also actively promoted the international interchange of technology and ideas. Technova's staff and advisors have made continuous progress, leaving their mark both nationally and internationally.

I recall that, in June 1982, at the Eighth Annual Summit of Developed Nations in Paris, French President Mitterand stressed the necessity for cooperation between science and technology. I examined future trends, and envisioned an ever-growing need for progress through the promotion of science and technology. With the cooperation of my many friends from beyond our borders, in July 1985 I established IMRA Europe, an international research and development laboratory, located in Sophia Antipolis, which is a research park in the suburbs of Nice, France. The laboratory began operations in June, 1988, and it has been actively involved in advanced research, mainly in the field of energy.

When I established IMRA Europe, I had a vision, world-wide in focus, to set up a global structure for the development of future technology. I named this project "the IMRA Plan." It had its research base in Japan, Europe, the U.S. and Asia, under the same name IMRA. Its purpose was to network these four regions together in order to make more efficient use of human resources by exchanging people and ideas, while winning the world's confidence, in order to achieve our goals. This plan progressed steadily, and now, Japan, IMRA Europe, and IMRA America have already begun work. Today, we are planning the establishment of IMRA Asia.

Thus, I have enthusiastically put my heart into promoting the development of future technology. At the same time, I have always felt anxious about the issue of alternative energy. The dire need to replace drained petroleum resources is a stark warning for the 21st century.

I felt strongly concerned in March 1989, when Dr. Fleischmann and Dr. Pons announced the cold fusion phenomena. Fortunately, I found an opportunity to invite both professors to Japan, where we became good friends. After close conversations with them, I became even more firmly convinced of the importance of cold fusion.

Later, when Technova received a joint research proposal from Professors Fleischmann and Pons, I was determined to do everything I could to offer them an opportunity to work to their hearts content, and allow them to become totally engrossed in the research. It was my judgement that IMRA Europe, located, as I said before, in Nice, South France, would be the ideal environment for them. So I offered this facility, and now, they are giving their undivided attention to advancing their research there.

Furthermore, in July this year, to advance cold fusion research more effectively, we opened IMRA Japan in the New Sapporo Technology Park, Hokkaido. With the cooperation of various experts, we are working on cold fusion right here in Japan.

To assure the success of a technology, obviously, there must be support from a wide variety of scientific fields. In other words, the harmonious development of science and technology is precisely the right way to achieve valuable results which can contribute to mankind. The reason we support cold fusion research actively is because, as a business enterprise, we feel we must contribute more to science.

Cold fusion is not just something to be studied by a single enterprise or a single nation. I am confident it will become a precious asset to all mankind, as the ultimate, ideal form of energy, so it should be shared among all the nations of the earth.

Therefore, this is my hope, and my message to you, the cold fusion researchers: please continue to work with all your might to make this new form of energy a reality, because you offer such hope to the coming generations of the 21st century. You will help them fulfill their greatest dreams and ambitions for the future. Thank you for your attention.

C. NEWS FROM THE U.S.

CALIFORNIA - SRI PROGRESS REPORT

M.C.H. McKubre, S. Crouch-Baker, A.M. Riley, R.C. Rocha-Filho, S.I. Smedley and F.L. Tanzella, (SRI International, Menlo Park, CA, U.S.A.), "Excess Power Production in D_2O - Electrolysis Cells: A comparison of results from differing cell designs," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Calorimetric studies have been undertaken of the "excess power" effect observed during the electrolysis of D_2O in cells employing palladium cathodes. Based on results obtained to date, it may be concluded that one criterion for the observation of excess power is the formation of highly-loaded compositions in the ß-phase of the Pd-D system (i.e. PdD_x with x larger than approximately 0.9, taken as an average over the entire cathode). In addition, it is apparent that the satisfaction of other criteria is involved, although these latter factors are presently less-well characterized.

In view of the loading-related criterion for the observation of excess power, it is essential that the internal geometry of the electrolytic cells be designed accordingly, and close attention paid to the electrochemical aspects of the loading process. In addition, it is desirable that the deuterium loading be monitored continuously *in situ* during the electrochemical experiment. Only in this manner may the instantaneous value of the apparent excess power be related directly to the (average) cathode loading.

In addition to the geometric influences on loading, variation of the cathode surface to volume ratio at equivalent loading may be used as a means to resolve the site of excess power production. In this work, the excess power behavior of two types of electrolytic cell, of differing designs with three cathode geometries, are described and compared. Based on this comparison, a number of observations may be made concerning the effects of cathode geometry and loading on excess power production.

EDITOR'S COMMENTS

Dr. McKubre reported on the EPRI-funded work that has been in progress for many months at SRI International. Over 20,000 experimental hours with the monitoring of up to 17 variables characterizes the extensive research performed by McKubre's group. Replication has been resolved to a large extent. Excess heat is usually observed after sufficient loading of the Pd cathode has been achieved. Bursts of up to 350% excess heat has been recorded a few times. Overall the occurrence of excess heat has been measured with a confidence factor of over 90 sigma. (Extremely unlikely to have occurred by chance.)

The work with the Pons-Fleischmann type of electrochemical cells is still characterized by difficulty in reproducibility. However, it has been clearly established that little or no excess heat can be expected unless the D/Pd ratio exceeds about 0.9. This loading ratio is a critical parameter. If the structure of the Pd (due to metallurgical processing) does not support high D/Pd ratios, the cell will not produce excess heat. Some success has been achieved by using "load and strip" cycles. This is achieved by loading up to an achievable level, reversing the current for a time to "strip" out some of the deuterium, then operating normally to "reload" the palladium lattice. These cycles may gradually increase the highest D/Pd ratio so as to achieve the 0.9 or higher that is required to observe excess heat production.

McKubre also reported successes in the use of "ionically conducting films of silicon and aluminum". These finely divided materials are added to the electrolyte in parts per million and appear to increase the amount of excess heat produced. *Fusion Facts* applauds this extensive work that has been accomplished at SRI International under EPRI funds. This effort represents the largest cold fusion research effort undertaken in the United States and should be continued.

NEW MEXICO - TAKAHASHI REPLICATION

Edmund Storms (NMT Division, Los Alamos National Laboratory, Los Alamos, NM, USA), "Measurements of Excess Heat From a Pons-Fleischmann Type Electrolytic Cell Using Palladium Sheet," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

Two pieces of palladium sheet similar to that used by A. Takahashi were loaded with deuterium in a Pons-Fleischmann type electrolytic cell and measurements were made of heat production. One sheet produced a steady increase in excess power that reached 7.5 watts (20% of input power) before the study was interrupted. A second similar sheet from a different batch of palladium did not produce any measurable excess power. There was a difference between the loading behavior, the maximum stoichiometry, and the presence of excess volume in the deuteride made from these materials. The first sheet contained 0.8% excess volume after having been deloaded from its maximum D/Pd ratio of 0.82 to 0.73, and the second sheet contained 13.5% excess volume while at its maximum D/Pd ratio of 0.75. The high excess volume in the latter case is an indication of internal cracks that reduce the required high D/Pd ratio.

EDITOR'S COMMENTS

Due to family illness Dr. Storms was unable to be at Nagoya and his paper was presented by Dr. Thomas Claytor. *Fusion Facts* published an abstract of the following paper in its August 1992 edition:

Edmund K. Storms (NMT Division, Los Alamos National Laboratory), "Measurements of Excess Heat From a Pons-Fleischmann Type Electrolytic Cell Using Palladium Sheet," submitted to *Fusion Technology*, also published as LAUR: 92:2390, dated July 2, 1992, 32 manuscript pages, 17 figs, 31 refs.

The presentation and the paper provide excellent information as to why some palladium samples "work" and others fail. By measuring the expansion of the palladium during loading and by the weight per unit volume, Storms shows how it can be determined whether the palladium has expanded so much by cracking that it can be expected to lose deuterium and therefore limit the achievable D/Pd necessary for producing excess heat. One of the frequent complaints from skeptics is that "the effect is not reproducible." This paper provides additional understanding as to metallurgical problems that limit the production of excess heat, although the same supplier provided both Pd samples.

CALIFORNIA - LIGHT-WATER EXCESS HEAT

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.

AUTHORS' ABSTRACT

Bush [4] has recently hypothesized that the light-water excess heat effect of Mills and the excess heat effect of Pons and Fleischmann [1] are essentially opposite sides of the same "coin", the latter being cold nuclear reactions in a lattice for which Bush has characterized the prototype as very likely being cold "alkali-hydrogen fusion." Mills [2], on the other hand, has claimed that the light-water excess-heat effect, as well as cold fusion, arises from an exotic chemistry in which hydrogen atoms collapse to radii significantly less than the Bohr radius under the conditions of his experiments. A consequence of his model is that an Na_2CO_3 experiment should yield no excess heat. His experiments have received initial confirmation from Noninski [3] and partial confirmation from Bush and Eagleton [4]. Thus, Bush and Eagleton [4] have obtained excess heat with K_2CO_3, but even greater excess power levels from Na_2CO_3 under otherwise comparable conditions. Srinivasan [5] of BARC has also seen excess heat with Na_2CO_3. The ratio of the excess power obtained by Bush and Eagleton [4] with Na_2CO_3 to that obtained with K_2CO_3, as well as other results of these experiments, support Bush's model [4] for cold fusion (or "alkali-hydrogen fusion"), the new three-dimensional TRM ("Transmission Resonance Model"). Studies have also been carried out with KOH, NaOH, and RbOH. In addition, results of studies on mixtures of light water and heavy water for some of these electrolytes will be reported. Bush's hypothesis of a cold nuclear reaction in the case of the light-water excess-heat effect receives initial support [3] from a quantitative correlation of nuclear byproducts with the excess heat observed: Strontium in the case of a rubidium cell and calcium in the case of a potassium cell.

[1] M. Fleischmann and S. Pons, "Electrochemically Induced Nuclear Fusion of Deuterium,", *J. Electroanal. Chem.*, 261, 301 (1989).
[2] R. Mills and K. Kneizys. "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion," *Fusion Technol.*, 20, 65 (1991).
[3] V. Noninski and C. Noninski, "Determination of the Excess Energy Obtained During the Electrolysis of Light Water," *Fusion Technol.*, 19. 364 (1991).
[4] R. Bush, "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.
[5] M. Srinivasan, B.A.R.C. (Bombay, India), Private communication, May, 1992.

CALIFORNIA - REVIEW OF ACCIDENT

S.I. Smedley, S. Crouch-Baker, M.C.H. McKubre and F.L. Tanzella (SRI International, Menlo Park, CA, U.S.A.), "Issues Relating to the Safe Operation of Electrolysis Cells," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

A convenient way of achieving very high D/Pd ratios, which are thought to be necessary for the observation of anomalous effects in deuterated metals, is by the electrolysis of heavy water with a palladium cathode. High loadings may also require relatively high current densities, and significant amounts of deuterium and oxygen can be produced. A number of people working in the field have experienced experimental situations where the gases have combined explosively, usually with inconsequential results. The objective of this paper is to outline the SRI experience, derived from an accident earlier this year, and to alert workers in the field of the seriousness of the explosion hazard from experiments involving the electrolysis of water. We will also describe experimental apparatus, safety equipment and procedures that allow experiments to be carried out with the necessary protection and safety. The issues of safety to be addressed concern primarily the non-steady state operation of recombination catalysts. Attention is thus directed to thermodynamically closed rather than open systems. More general issues of safety exist in experiments intended to generate heat potentially from nuclear processes. In order to ensure the safety of workers in this field, we therefore propose the establishment of an international committee on safety, to meet regularly and provide a forum for discussion, deliberation and dissemination of safety-related information.

EDITOR'S COMMENTS

Fusion Facts applauds both the authors and the conference committee for giving this report the forum deserved. As the late Dr. Riley was a personal friend, our staff will do all that is requested or deemed appropriate to help bring safety issues to the attention of all cold fusion experimenters. The authors suggest that an international committee be set up to deliberate and disseminate safety concerns and information. This publication will assist in any appropriate manner.

Dr. Smedley related that without the face mask he was wearing he would likely have lost his sight. Dr. Riley was killed when hit by a 6 inch long steel cylinder. The explosion was apparently caused by the failure of a recombiner, the continued production of evolved gases, the ignition of the gases, and the momentary development of pressures exceeding 300 atmospheres. Dr. Smedley's conclusions are:

1. Passive recombiners cannot be relied upon.
2. All electrolysis cells should be contained in shielded environments.
3. No cell should be removed until it is at one atmosphere pressure. [The pressure gauges used may also have failed, as was apparently the case in this tragic accident.]

It was suggested that the evolved deuterium and oxygen should be removed from a cell (while in a protective environment) and replaced with nitrogen gas at 1 atmosphere pressure.

UTAH - BYU UPDATE

Steven E. Jones (Dept. of Physics and Astronomy, Brigham Young University, Provo, Utah USA), "Update on BYU Research," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

A first paper on what is now known as cold fusion was written in 1985 [1]. In May 1986, we began an experimental program at BYU to search for nuclear effects due to cold fusion in deuterium charged metals as well as in geological processes, supported by the US Dept. of Energy. We found and published evidences for anomalous nuclear reactions occurring in the laboratory as well as naturally in the earth. [2, 3] Experiments have recently been completed in Japan with scientists from the University of Tokyo and elsewhere. A new underground laboratory facility designed for cold-fusion studies has also begun operation inside a mountain 10 km from the BYU campus. Results from these experiments will be described.

[1] C.D. Van Siclen and S.E. Jones, "Piezonuclear Fusion in Isotopic Hydrogen Molecules," J. Physics G: Nuclear Physics 12: 213-221 (March 1986).

[2] S.E. Jones, E.P. Palmer, J.B. Czirr et al., "Observation of Cold Nuclear Fusion in Condensed Matter," Nature 338:737-740 (1989).

[3] S.E. Jones, F. Scaramuzzi, and D.H. Worledge, eds., "Anomalous Nuclear Effects in Deuterium/Solid Systems," BYU October 1990, American Inst. of Physics: Conf. Proc. 228 (1991).

EDITOR'S COMMENTS

Dr. Jones explored the problem of nuclear "ash" commensurate with the amount of excess heat that has been measured from many experiments. He showed a chart in which the amount of "ash" is shown for 20 different nuclear reactions. The nuclear reactions that have been proposed to explain the light-water alkali-metal fusion were not predominant. Dr. Jones mentioned that the production of X-rays is a critical test for nuclear reactions. [Recent evidence for X-ray emission from light-water cells is nearing publication and as much information as can be released will be reported in *Fusion Facts* as soon as possible.] Dr. Jones showed slides of the work done at the Kamiokande tunnel in Japan. Some bursts of neutrons were seen, especially from cement made with heavy water. [Dr. Nate Hoffman observed that, "This is the first **concrete** result we have had." *Non-English readers, please note this is a pun.*] Dr. Jones observes that finally they have reproducibility (with the heavy-water cement) in producing neutrons. Pictures of the new tunnel facility near the BYU campus were shown and the scientific community has been invited to use the facility. In his conclusions Dr. Jones noted that about 10^{12} ash atoms per second, especially X-rays, will be produced with any measurable excess heat. In the question period Dr. Bockris said that the main point has been proved by the neutron/tritium ratio being of the order of 10^{-8} and that there is heat and other types of nuclear products [other than neutrons.] "If you can't accept

heat as being the result of fusion then explain it as chemical." Dr. Jones suggested that the shoe is on the other foot. [Proponents of cold fusion must prove that it is not chemical.]

CALIFORNIA - ANOMALOUS EFFECTS

M.H. Miles and B.F. Bush (Naval Warfare Center, Research Department China Lake, CA), "Search for Anomalous Effects Involving Excess Power, Helium and Tritium during D_2O Electrolysis Using Palladium Cathodes," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Electrochemical calorimetric measurements in the search for excess power production include six experiments with palladium rod cathodes in D_2O solutions and two experiments with similar palladium cathodes in H_2O electrolytes. New palladium rods were used in each study, but no significant excess power was observed. Our previous studies in D_2O-LiOD with similar sized palladium rods (d= 0.635 cm) yielded excess power in seven out of eight experiments along with evidence for helium production [1, 2]. The same palladium cathodes were always re-used in those earlier experiments. Several other differences in the palladium rod experiments that yielded excess enthalpy and studies that failed to show this effect are being evaluated. Progress relating to helium measurements have been hindered by difficulties in obtaining the excess power effect.

Calorimetric measurements for 33 experiments using the electrodeposition of palladium from D_2O-LiCl + $PdCl_2$ solutions as reported by Szpak et al. [3] showed possible excess power in only two experiments. The recombination of D_2 and O_2 was nearly always present to some extent in these experiments, hence measurements of the gas evolution rate complicated the calorimetry. Apparent excess power was often present, but the correction for recombination generally resulted in an equal power input and output for the cells. The two electrodeposition experiments that still showed the production of excess enthalpy after correcting for the recombination of D_2 and O_2 gases both yielded about 0.15 W for the maximum excess power. Assuming that all of the palladium salt is electrodeposited onto the copper cathode, this yields 67 W/cm^3 of palladium metal at a current density of 200 mA/cm^2. The excess power was present for only about one day in the first experiment but persisted for about 5 days in a later experiment.

Electrolyte samples for tritium analysis were taken at the end of each experiment. The largest tritium increase was for a palladium rod experiment in D_2O that showed a 99.4% increase in the tritium level (346 DPM increasing to 690 DPM). The largest tritium increase in an electrodeposition experiment involving LiCl-$PdCl_2$ dissolved in D_2O was 52% (334 DPM increasing to 508 DPM). These tritium increases, however, are not clearly beyond levels expected for electrolytic enrichment due to isotopic separation factors. Some experiments showed very small increases in tritium during electrolysis and even puzzling decreases in the tritium content of D_2O.

Two experiments have been completed using palladium plate cathodes (Tanaka Metals) as in the studies by A. Takahashi [4]. No significant excess power was observed after more than 30 days of electrolysis. Our studies were conducted in isoperabolic calorimeters [1] with small cathodes (A= 2 cm^2) whereas A. Takahashi [4] used flow calorimetry, thus our cell temperatures increased from about 28°C at the low current mode (25 mA/cm^2) to over 50°C at the high current mode (400 mA/cm2). The lower cell temperatures and much smaller temperature changes in the flow calorimetry system used by A. Takahashi [4] may be a critical factor in obtaining high deuterium loading of the palladium. Modified experiments are planned for palladium plate cathodes that maintain a low cell temperature during the loading period.

References

[1]. M.H. Miles, K.H. Park, and D.E. Stilwell, *J. Electroanal. Chem.* 296, 241 (1990).
[2]. B.F. Bush, J.J. Lagowski, M.H. Miles, and G.S. Ostrom, J. Electroanal. Chem., 304, 271, (1991).
[3]. S. Szpak, P.A. Mosier-Boss, and J.J. Smith, *J. Electroanal. Chem.* 302, 255, (1991).
[4]. A. Takahashi, Proc. Int. Symp. Nonlinear Phenomena in Electromagnetic Fields, ISEM-Nagoya, Japan, Jan. 27-29, 1992.

EDITOR'S COMMENTS

Miles reported that with previous Pd they achieved 7 out of 8 successes. With the present palladium they have had 8 out of 8 failures. In considering alternative explanations of excess heat the authors' have looked at the Joule-Thompson effect, the Van der Waal's equation of state, and the power effect. None of these explained the excess heat observed. The author's reported on their plans for additional measurements of the amount of ^{4}He produced from a working palladium/heavy-water/lithium cell. Part of the plan is to use stainless steel instead of glass which has a lower ability to absorb helium. The detection limit for ^{4}He is about 10^{13} atoms in 500 ml. With excess heat being produced there should be about 10^{11} to 10^{12} atoms per sec per watt.

NEW MEXICO - SOLID STATE GAS CELL

T.N. Claytor, D.G. Tuggle and H.O. Menlove (Los Alamos Nat'l Lab., Los Alamos, NM), "Evolution of Tritium from Palladium in the Solid State Gas Cell," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Tritium has been produced in palladium and silicon stacks when pulsed with a high electric current. These palladium-silicon stacks consist of alternating layers of pressed and deuterided palladium powder or foil and silicon powder or silicon wafers. Prior to our most recent experiments, deuterium containing tens of nanocuries of tritium per cell were used at pressures over ten atmospheres. Current cells use deuterium with less than a nanocurie total tritium at a deuterium pressure of just over one atmosphere. The deuterium is circulated in a loop containing the cell and through an ionization chamber to measure the tritium increase as a function of time. As we found before, the foil cells have produced small but steady amounts of tritium and the powder cells, with oxidized palladium, were the most prolific producers. Over 4800 hours of data, spanning 10 cells, have been collected with this system. We have run active cells as well as control cells and hydrogen and deuterium backgrounds. Tritium production has varied from 0.02 to 0.2 nCi/hr. Because of our increased sensitivity, it is usually possible to determine if a cell is active within 48 hours. Our rapid turnaround and increased sensitivity have been somewhat offset by the fact that after a large amount of tritium has been generated, it takes up to a week to clean up the loop to return the background to a low level. Due to experimental constraints we have not been able to measure neutron output with these cells while simultaneously measuring the tritium increase. However, at the 0.2 nCi/hr rate the expected neutron count rate is only 2 counts an hour above background (approx. 44 c/hr) so there is little incentive to use the neutron counter until the tritium production can be raised by at least a factor of two. The question of tritium contamination in the palladium has been primarily resolved by the development of techniques that allow the palladium powder or foil to be reused. Thus, powder or foil that has been used in a hydrogen background experiment where only background drift of the system was observed could not be capable of generating tens of nanocuries in a subsequent deuterium experiment via contamination. Various methods for increasing the tritium production, such as, increased current density, surface modifiers, and higher deuterium loading, will be discussed.

EDITOR'S COMMENTS

Dr. Claytor showed slides of some of the Pd disks after using in his tritium-generating experiments. Some of the disks showed cracks and some showed signs of arcing from the non-linear distribution of electrical current through the stacked Pd/Si layers. Claytor is also doing some glow-discharge work but without reportable results as yet. In forming tritium, he found that with the arcing turned off there was still tritium being produced. Some cells were hydrided for about 50 hours and then run with the high voltage across the cell stack. In the use of highly divided powder, the authors found that there was faster development of tritium production. Control cells were also used. **In summary**, the authors claim: Palladium powder is better than Pd foil to produce tritium. The foil must be annealed to produce tritium. The tritium is a function of current. The foil produces tritium when the voltages used are 200 volts and higher. There is no decrease in tritium production when the equipment is moved into a tunnel [ergo, natural radiation is not a factor.] The neutron/tritium ratio is anomalous [as compared to high-temperature gas plasmas] with n/t less than 10^{-8}. The addition of hydrogen is not effective.

TEXAS - TRITIUM PRODUCTION + ^{4}He

J. O'M. Bockris, C. Chien and Z. Minevski (Texas A&M Univ.), "Tritium and Helium Production in Palladium Electrodes and the Fugacity of Deuterium Therein," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

An account is given of the massive production of tritium at a Pd electrode. Production continued for about 750 hours after which time it was arbitrarily curtailed. Production of T was found to cease every few days but could be resuscitated by increasing the overpotential of the electrode reaction. A logarithmic relation between the rate of tritium production and the overpotential of the electrode reaction was established. Addition of fresh D_2O or vibrating the Au electrode halted the T production which began again spontaneously if a pause of 1-2 days was allowed. Extreme caution to avoid the possibility of contamination was taken: the Will-Czedynska method of examining T contamination in specimens from the same rod as that used as electrode material was dissolved in aqua-regia and the resulting material distilled. The distillate contained nothing above background of T in all cases, if no D_2O had been electrolytically evolved on the Pd specimens concerned. Where the latter occurred, the T content detected by dissolution was the same as that obtained by anodic polarization. Examination of the electrode surface in XPS showed that it was covered with numerous metals and silicates. A particular copper-mosaic structure characterized the tritium-active electrode.

Helium production was found to accompany that of T. The He was analyzed by thermal expulsion and mass spectroscopy (N. Hoffmann). No He^3 was found but He^4 was measured in nine specimens out of ten examined. The amounts present correspond to 2-100 times background. Voids were also detected about 1 micron within [below surface] the electrode.

The Szpack-Boss method for reducing the initiation time for the production of T was examined. The simultaneous deposition of D_2 and Pd on a Au substrate allowed a rapid saturation of very small nuclei of Pd on the Au. The result was T production to about 3 times above background, beginning in a time as little as 10 hours after the Pd had been deposited. The T was produced in bursts, each of which lasted for 2-3 days.

An examination was made of the electrode surface corresponding to short and long-term electrolysis. Among materials found on the surface were Si, Fe, Cu, Ni, etc. Only occasional patches of Pd could be seen. The Devanathan-Stachurshi approach was used to examine the

dependence of the solubility of D in Pd on potential; the diffusion coefficient of D into Pd as a function of concentration; and the initiation conditions for cracking of the interior of the Pd electrode. The cracks produced were examined metallurgically; and related to the overpotential for the D_2 evolution reaction at Pd; and to the surface concentration of D on Pd (obtained by FTIR spectroscopy). The fugacity of the D_2 in voids was related to the overpotential, and to the initiation of cracking.

EDITOR'S COMMENTS

This was the last paper to be presented orally at the conference and one of the most interesting. The careful manner in which the palladium was handled for both before and after analyses ensures the validity of the findings by Dr. Nate Hoffman's group. For example, the measurements made on the Pd cathode showed ^4He levels as high as 300 times background. The use of a method for plating palladium deuteride onto gold resulted in 6 positive experiments out of 7 in terms of success in producing tritium. Dr. Bockris made a strong point by stating, "You must control overpotential if you want to standardize experimental results." The observation that the addition of H_2O to the cell would stop the production of tritium indicates that the tritium production must be a surface effect. The fugacity of the deuterium in the Pd lattice appears to be equivalent to about 10^{10} atmospheres. Bockris would like to make an experimental arrangement in which he would have an on-line test for ^4He. He stated that this could probably be achieved by using a laser to ionize the helium. Dr. Hoffman stated that the tests on the Pd rods were done by Bryan Oliver; that no ^3He was found; and that etching did not remove the ^4He; ^4He was found in 10 samples of the rod; and that none of the pretest samples showed helium.

NEW YORK - HOT IN JAPAN
Courtesy of Steve Roen

Andrew J. Pollack (Staff Writer), "Cold Fusion, Derided in U.S., Is Hot in Japan," *Science Times section of New York Times*, Nov 17, 1992, page C1.

EDITOR'S COMMENTS

This page of information contains two subheadings: "With plentiful financing and no critics, cold fusion experiments find friendlier ground" [in Japan] and "A conference is either a scientific turning point or a religious revival." At the First Annual Cold Fusion Conference an officer of the American Physical Society labeled it a wake for a dying corpse. Now the *New York Times* would like us to believe in a magical revival. The six file drawers of positive articles collected from over twenty coutnries suggests that cold fusion never died! The article is an interesting combination of progess reports, history, and laced with plenty of negative comments from some of the skeptics such as Dr. Huizenga. In the final paragraph the article reports, "Other researchers, mainly from the United States, said they could produce excess heat using regular **light** water and nickel electrodes. This is even harder for scientists to accept than the original form of cold fusion." One of these days, even the New York Times will finally find out that cold fusion is an exciting new science, but not this year.

D. NEWS FROM ABROAD

JAPAN - EXCESS HEAT AND D/Pd RATIO

Keiji Kunimatsu (IMRA Japan Co. Ltd., Sapporo, Japan), "Deuterium Loading Ratio and Excess Heat Generation During Electrolysis of Heavy Water by a Palladium Cathode in a Closed Cell Using a Partially Immersed Fuel Cell Anode," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

We have developed a noble electrolytic cell pressurized by deuterium gas in which deuterium loading ratio in a palladium cathode can be determined in-situ during the cold fusion experiments. A gas-diffusion type fuel cell anode which was partially immersed in the electrolyte served as an anode to ionize deuterium gas to deuterium ions. The loading ratio can be determined from the deuterium gas pressure decrease during the electrolysis at constant current. The temperature in the electrolyte, in the palladium cathode and in the gas phase were monitored simultaneously with other parameters such as pressure, cell voltage, cell current and hydrogen overvoltage on palladium measured against the reversible hydrogen electrode (RHE) in the same solution.

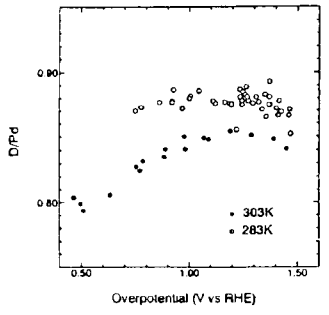


Fig. 1 Dependence of D/Pd on overvoltage

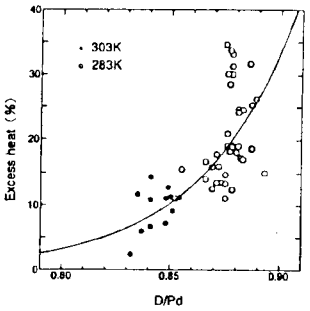


Fig. 2 Dependence of excess heat on D/Pd

Fig. 1 and 2 demonstrate a result showing dependence of the loading ratio, D/Pd, on the hydrogen overvoltage which has been corrected for the Ohmic resistance of the electrolyte, and the excess heat generation with respect to the input electrolytic power as a function of D/Pd in 1M LiOD. The excess heat generation becomes prominent around D/Pd =0.85. Currently we are trying to go into the region of the higher loading ratio.

JAPAN - CLOSED CELL

Noboru Oyama, Takashi Terashima, Seiji Kasahara, Osamu Hatozaki, Takeo Ohsaka and Tetsu Tatsuma (Dept. of Applied Chem., Tokyo Univ. of Agriculture and Technology), "Electrochemical Calorimetry of D_2O Electrolysis Using a Palladium Cathode in a Closed Cell System," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

In a recent paper, we reported on observation of excess heat during D_2O electrolysis using a Pd cathode in an open system.[1] In the open system however, the evaluation procedure for excess heat is complicated because it is difficult to estimate the heat which is generated through the recombination of D_2 and O_2. Thus we addressed ourselves to experiments in a closed system in which D_2 (or H_2) and O_2 generated are recombined on a catalyst so that the excess heat can be evaluated more precisely.

Electrolysis of D_2O containing LiOD (0.1 M) or H_2O containing LiOH (0.1 M) was performed with a two-electrode system in a twin cell. A Pd rod (2.0 mm in diameter and 5.0 mm in length) of > 99.9% purity (Tanaka Kikinzoku, Japan) and a Pt gauze were used as the cathode and anode, respectively. The product of the electrolytic current and the voltage was kept at 0.200 W. The other twin cell was filled with a solution of the same amount and the same composition as was the electrolytic cell, and it was used as the reference. Those twin cells were set in a calorimeter (model MM 5111, Tokyo Riko, Japan) which is kept at 8.0°C and the difference in generated heat was measured every 5 seconds. All D_2 (or H_2) and O_2 generated and liberated to a gas phase were recombined on a catalyst, Pd black supported on a Pt wire.

Figure 1 shows the time-course of the ratio of "excess heat (W_{ex})" to input power (W_{in}). Continuous generation of excess heat was observed since the 12th day after beginning of D_2O electrolysis. The total energy produced for 27 days was 12.1 kJ, that means 2.42% of the power input. Excess heat per unit volume was O.57 W cm^{-3}. On the contrary, no significant generation of excess heat has been observed for H_2O electrolysis. Thus obtained excess heat was statistically examined and the value was certified to be larger than the error.

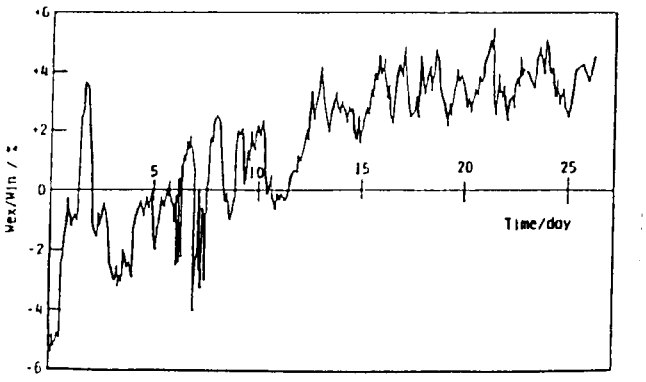


Fig. 1. Energy balance for the electrolysis of LiOD/D_2O at 8.0°C

[1]. N. Oyama, T. Ohsaka, O. Hatozaki, Y. Kurasawa, N. Yamamoto, S. Kasahara, N. Ohta, Y. Imai, Y. Oyama, T. Nakamura, T. Shibata, M. Imamura, Y. Uwamino, S. Shibata, *Bull. Chem. Soc. Jpn.*, 63, 2659 (1990).

EDITOR'S COMMENTS

These experimenters used a closed cell system with constant power through the cells. A palladium-black catalyst was used for a recombiner in these closed cells. One experiment out of a total of five exhibited excess heat. It was stated during this session that the addition of aluminum powder increased the excess heat by 2 to 4 percent.

JAPAN - HYDROGEN IN CATHODES

Michio Enyo (Catalysis Research Center, Hokkaido Univ., Sapporo, Japan), "Hydrogen/Deuterium Concentration in Pd under Cathodic Polarization," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

Hydrogen electrode reaction (HER) provides a high hypothetically equivalent hydrogen pressure as demonstrated by strong reducing ability of the hydrogen evolving cathode or, more directly, by high concentration of hydrogen established in hydrogen-absorbing metal cathodes, typically Pd. Recently, strong interests are focused on Pd HER, as attainment of very high deuterium concentration in Pd metal is believed to be a decisive factor to cause the alleged cold fusion.

The present author has discussed earlier the hydrogen pressure equivalent to hydrogen overpotential on, and accordingly hydrogen concentration in Pd cathode [1, 2]. The basic concept in the discussion was the evaluation of chemical potential of the hydrogen adatom H(a) on the electrode surface, the reaction intermediate of HER, which was established during cathodic polarization. It was shown in the framework of a mixed rate-control model that the equivalent hydrogen pressure should not generally be related to the hydrogen overpotential by a simple Nernst-type equation but, nevertheless, it is still accountable quantitatively through analysis based on the HER mechanism. Further, the equivalent hydrogen pressure data are experimentally obtained by observing the overpotential decay transient that follows upon interruption of the polarization current after a steady state polarization condition is reached. It became clear at the same time that catalytic poison which retards the hydrogen recombination reaction, 2H(a) > H_2, would raise the pressure. [3]

The highest value observed of the equivalent pressure was ~10^4 atm, or the corresponding hydrogen concentration in Pd was close to H/Pd~0.9 Supplementary measurements have been made recently in order to see how high a pressure is attainable at high current densities, by choosing different electrolyte or modifying the system with use of catalytic poisons. The highest value then observed at a current density of 0.2 A cm^{-2} in 0.5M H_2SO_4 which contained 30μM thiourea as a poison was ~10^6 atm. One anticipates that the hydrogen concentration would then reach H/Pd~1.0 (or somewhat lower value, D/Pd~0.9, in deuterium system because of lower solubility of deuterium). There may be a chance to find more effective poisons which still raise the pressure. [Note that some papers use the term "promoter" instead of "poison".]

[1] T. Maoka and M. Enyo, Electrochem. Acta, 26, 607, 615 (1981).
[2] M. Enyo, in Comprehensive Treatise of Electrochemistry, vol 7, ed. B.E. Conway, et al., Plenum, New York (1983), pp. 241-300.
[3] B. Baranowski, Z. Szklarska-Smialowska and M. Smialowski, Proc. of the 2nd Congress on Catalysis, Paris (1960), 2269.

EDITOR'S COMMENTS

This was deemed to be an important paper. However, the difficulty in understanding the presentation and the small size of print on the transparencies made it difficult to take appropriate notes. *Fusion Facts* will try to get a preprint and report more fully on this important aspect of cathode "loading".

JAPAN - ABCs OF HYDROGEN/METALS

Yuh Fukai (Department of Physics, Chuo University, Tokyo), "The ABC's of the hydrogen-metal system," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHOR'S ABSTRACT

One of the characteristic features of the cold fusion community is the diversity of the disciplines of its constituent members. This has made the proper evaluation of the work in this field extremely difficult, and also helped many people to foster undue hopes for the occurrence of cold fusion phenomenon by seeking their rationales in something they are not familiar with. The purpose of this paper is to explain some of the very basic physical concepts and properties of the hydrogen-metal systems to provide a necessary background for considering this phenomenon. First, equilibrium properties of the hydrogen-metal systems are described, including their structure and energetics, and their implications for sustaining D-D pairs at close distances are examined. Various misconceptions about the state of hydrogens in metals, held even by some theoreticians, will be rectified. Second, dynamical (non-equilibrium) processes to be induced by energetic particles incident upon hydrogen-metal systems will be described. I wish to emphasize that these ABC's of the hydrogen-metal systems must be shared by everyone in this field of research. In order to attest the occurrence of cold fusion, one must find some way to overcome difficulties posed by these ABC's; they cannot be simply ignored as too frequently done in the past.

EDITOR'S COMMENTS

This is an important basic paper and should be carefully considered by all workers in the new science of cold fusion. Fukai shows that the often-cited Coulomb barrier and the resulting calculations of the probability of deuterium fusion in a metal lattice loaded with deuterium does not take into account the traveling (or itinerant) deuteron! He also reports on the chemical energy stored during hydriding which can be given off later and incorrectly counted as excess heat. The author cites that at a H/Pd ratio of 0.89 only 18% of the sites are occupied. He also shows that up to 6 deuterons can be trapped around a vacancy in the metal lattice and that vibrational energy levels must be considered. However, he warns that at the energy levels used the potential undulation is very small. He states, "D-D pairs cannot exist in any solid!" The reason is that the energy of close pairs is about 42 Ev whereas the energy of lattice distortion is only about 1 Ev. He also reports that acceleration of charged particles is impossible in metals. Reactions are only possible on the surface. He suggests the careful study of the book, The Metal Hydrogen Systems, published by Springer-Verlag, Jan. 1989. [Considering the strong points made in this paper, experimentalists, modelers, and theorists should look carefully at other fusion reactions than D-D. Nuclear catalysis, alkali-metal/hydrogen fusion (Bush's revised TRM), and other explanations should be more carefully considered.]

JAPAN - DRIVES UP NTT STOCK

Eiichi Yamaguchi and Takashi Nishioka (NTT Basic Research Labs, Tokyo, Japan), "Direct Evidences of Nuclear Fusion Reactions in Deuterated Palladium," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Elementary processes of nuclear fusion reaction in solids have been studied by providing deuteron-loaded palladium (Pd:D) in a vacuum system having real time calorimetry, energy spectroscopy for emitted charged particles; and mass spectroscopy for released gases. The key factor of this study is heterostructures fabricated by depositing thin film oxides and Au on one and the other surface of Pd:D plate. The oxides provide a surface barrier for ionic transport of deuterons, while the Au film blocks the transport. The controlled out-transport of deuteron atoms is expected so that D accumulates as a layer below the oxide deposited. In the initial stage of our study, we

observed gigantic neutron bursts of (1-2) x 10^6 n/s, explosive gas release, uniform biaxial bending caused by plastic deformation, and excess heat evolution, all at the same time, from MnO_x/Pd:D/Au systems set in a vacuum chamber [1]. The latter three phenomena were observed also by applying this method to Pd:H systems having the same heterostructures [2]. This is the first evidence for the fact that the excess heat production is not necessarily caused by regular D-D reactions. We applied electric current of 0.5-0.8 A/cm^2 perpendicularly to the sample plate. With 100% reproducibility in obtaining the excess heat evolution, explosive gas release and rapid plastic deformation, it has been found that these phenomena result from D (H) transport due to the temperature and strain gradients induced by the current. Charged particles emission (presumably proton) with the maximum energy of approximately 3 MeV was also detected from Pd:D [3]. The occurrence of the charged particles burst was strongly correlated to the excess heat evolution and gas release and suggests that the fusion reaction of D + D -> $^1p(3MeV) + ^3t(1MeV)$ takes place. Recently, we have added an ultra-high resolution mass spectroscopy system (EX-TREL) to our measurement system, which can even resolve the difference in mass number between ^{4}He (4.0026031 amu) and D_2 (4.0282044 amu). We have found a signal attributable to the production of ^{4}He during the excess heat evolution. This [experimental measurement] will give a direct and definite evidence for a new class of nuclear fusion reaction in solids.

[1.] E. Yamaguchi and T. Nishioka, Jpn. J. Appl. Phys., vol 29 (1990), L666.
[2.] E. Yamaguchi and T. Nishioka, Proc. of Int. Progress Review, "Anomalous Nuclear Effects in Solid/Deuterium Systems," Provo, Oct. 1990, p. 354.
[3.] E. Yamaguchi and T. Nishioka, Proc. of Int. Symp. on Nonlinear Phenomena in Electro-Magnetic Fields, Nagoya, Feb. 1992; to be published.

EDITOR'S COMMENTS

A public announcement of this experimental result, given as a press conference in Tokyo, resulted in the increase in NTT share price of about 10%. Yamaguchi pointed out that it requires a vacuum environment to measure the production of possible nuclear reaction byproducts such as ^{4}He, ^{3}He, and T_2. In addition, charged particles can best be measured in a vacuum. The measurement of neutrons requires a location with minimal background radiation. In addition, a key mechanism is that the D/Pd ratio locally must be greater than about 0.9. The design of Yamaguchi's experiments has observed these environmental needs. The first positive result of his work was observed on July 4, 1989. Yamaguchi reports that in this experimental work the phase transition of Pd to D/Pd of about 1P occurs locally in a thin layer which cause a Gorsky effect and the vacancy in the Pd promotes the fusion reaction. The results of the replicatable successful experiments produces ^{4}He + heat + charged particles. The neutron production is a function of the loading ratio. A slide was shown with the conclusion that the nuclear reaction T + p(3MeV) produces an alpha particle plus low-energy p. Dr. Nate Hoffman asked about the use of glass and was told that "it is an all-metal system."

JAPAN - DEUTERON IMPLANTS

Toshiyuki Iida, Morio Fukuhara, Hiroaki Miyazaki, Yasuhiro Sueyoshi, Jun Datemichi, & Akito Takahashi (Department of Nuclear Engineering, Faculty of Engineering, Osaka University), "Deuteron Fusion Experiment with Pd Foils Implanted with Deuteron Beams," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

In order to examine the "cold" deuteron fusion reaction in Pd, we have tried to do some experiments, with Pd foils implanted with deuteron beams. A 20cm dia. x 24cm cylinder-type vacuum chamber with 14 measuring ports was installed at the end section of a 250keV deuteron accelerator. In the center of the chamber, a 19 micrometer thick Pd foil was set to face toward the collimated deuteron beam less than 1 mm in diameter. The backside of the foil was coated with 0.3 micrometer thick Ag layer to suppress the diffusion of deuterium. Three Si-SSDs and a microchannel plate with electric deflection plates were prepared for the measurement of high energy particles emitted from the foil by the supposed deuteron fusion reactions. Almost all detection signals came from the well-known D-D reaction. However, the Si-SSD set up behind the foil detected a very few but significant counts in the 3-5 MeV energy region, which exceeded the highest energy 3 MeV of protons from the D-D reaction. We are now trying to find out the origin of these inexplicable signals, i.e., the identification of the particles, and are also discussing the relation to the 4.75 MeV tritons and ^{3}He which are assumed by the three-body fusion model [1] as a hypothetical explanation of the mechanism of the cold fusion phenomena. We are planning to do further similar experiments under the following conditions; (1) changing the temperature of the foil, (2) giving mechanical stress to the foil and (3) flowing an electric current on the foil.

[1]. A. Takahashi, "Nuclear Products by D_2O/Pd Electrolysis and Multibody Fusion", Proc. Int. Symp. Nonlinear Phenomena in Electromagnetic Fields, Nagoya, Japan (1992).

EDITOR'S COMMENTS

Dr. Iida showed a slide of several possible nuclear reactions and suggested that at least some of the nuclear reactions from electrochemical cells should be observed with deuteron beam work. During the experiments a pulsed beam was used to irradiate Pd or Ti targets on 1 side. Iide showed a slide of how a deuteron beam is used to impact a foil. Investigating the spectra produced from targets, with the use of Al foil to screen out lower energies, it was shown that some 3.6 up to 8.0 MeV particles were produced in addition to the expected 2.6 MeV

particles from Ti targets. With Pd targets the higher energy levels were much smaller. One of the possible explanations of the higher energies is that of multi-body fusion reactions. Some skeptics suggest that such multi-body fusions should be highly improbable.

JAPAN - HIGH ENERGY PROTONS

J. Kasagi, K. Ishii, M. Hiraga and K. Yoshihara (Tohoku Univ.), "Observation of High Energy Protons Emitted in the TiDx + d Reaction at Ed = 150 keV," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

We have bombarded highly deuterized Ti with a 150-keV deuteron beam and have measured energetic charged particles emitted in the bombardment. Targets used were various plates and rods of TiDx, into which deuterons were heavily loaded by the Sieverts method. Detectors were a surface barrier Si detector of 2 mm in thickness and a Li-drifted Si detector of 5 mm in thickness, which can stop protons with energies up to 18 and 30 MeV, respectively.

Unexpectedly, charged particles with energies up to about 17 MeV is observed in the energy spectrum obtained at 135° for the deuteron bombardment of a split section of a 10-mm dia rod; the Q-value of the D(d,p)t reaction is only 4.033 MeV. These high energy charged particles were identified to be protons by changing an Al absorber covering the front face of the detector. The events below about 9 MeV can be explained as protons from the D(d,p)T reaction and their pile-up events, since edges of the double and the triple pile-up can be clearly seen in the spectrum. In addition to these non-strange events, there exist a broad peak for 12.5 < Ep < 16.5 MeV and a sharp peak Ep = 14.1 MeV, which are superimposed on continuous protons.

As described in our other contribution, the sharp peak is important evidence for anomalous concentration of ^{3}He in Ti during D_2 gas loading. We have only three cases showing clearly the sharp peak. By contrast, the broad peak can be always observed for any TiDx targets of x > 1, and is interpreted as protons emitted in the sequential D(^{3}He,p)α reaction following the D(d,^{3}He)n reaction; the peak cannot be sharp due to the spread of energy and direction of ^{3}He being the beam of the secondary reaction. Thus the spectral shape depends on the angular distribution of ^{3}He, the energy loss of ^{3}He in Ti, the cross section and angular distribution of the sequential reaction. The calculation including these effects can reproduce the observed spectrum very well. The ratio of the yield of the broad peak to that of the protons from the D(d,p)T reaction can give the deuteron density at the specific region of TiDx where the beam bombards. The densities deduced with this method generally agree with the averaged one obtained by weighing.

EDITOR'S COMMENTS

The Ti rod used was obtained from Nippon Mining Co, Ltd. The Ti rod is degassed at 800 C for about 20 hours under a pressure of about 10^{-5} Pa and then soaked in D_2 deuterium gas at 3 atm pressure for more than 24 hours. The resulting D/Ti ratio ranged from 0.6 to about 1.9. The bombardment used a 150 KeV deuteron beam with a 3 nanometer circle and currents of 0.5 to about 10 microamperes. The results showed a peak at about 14.1 MeV with a broad bump from 12.5 to 16.5 MeV. The peak could be due to a ^{3}He + d --> p + d reaction. The broad band could be explained by D + ^{3}He -> p + ^{4}He reaction. There are problems in understanding the data. Where do the atoms come from that participate in the reaction? How is the broad bump of energy made? It was suggested that the bump could be due to energetic particles coming from different directions. At times it was observed that the source of the particles was from one spot in the rod. [This finding is consistent with other observations made with deuterium-loaded titanium chips as shown by autoradiography.] An explanation for the source of ^{3}He is that it may be formed during the deuterium gas loading. [This idea is consistent with observations that some titanium should activate tritium spots by self-radiography.]

INDIA - LIGHT-WATER CELLS

M. Srinivasan, A. Shyam, T.K. Shankarnarayanan, M.B. Bajpai, H. Ramamurthy, U.K. Mukherjee, M.S. Krishnan, M.G. Nayar and Y. Naik, (Bhabha Atomic Research Center, Bombay, India), "Tritium and Excess Heat Generation During Electrolysis of Aqueous Solutions of Alkali Salts with Nickel Cathode," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

A number of open-cell type electrolysis experiments of the Mills and Kneizys type using Nickel as cathode, Pt wire as anode and aqueous solutions of carbonates of Potassium, Sodium and Lithium as electrolyte have been carried out in three different laboratories at Trombay. The electrode geometry was cylindrical and similar to that employed by Mills and Kneizys. Initial experiments used solid nickel sheet as cathode. But most of the subsequent experiments have used locally manufactured porous nickel electrodes deployed routinely in hydrogen generators being made at BARC. The cells were fabricated out of dewar type commercial vacuum thermos flasks. The difference in temperature at equilibrium between the operating cells and that of an identical non-operational reference flask was measured to deduce excess heat. The **cell constant** which was determined by means of a built-in resistance heater was in the range of 16°C/w to 50°C/w depending on top plug design. The time to reach equilibrium varied from 8 hrs. to 24 hrs. in different cells. In all about 20 experiments have been carried out so far with various electrolytes. In some cases a mixture of H_2O and D_2O was used

with the added D_2O content varying from 0% to 100%. At one of the laboratories a bank of 5 cells is being operated in series continuously for durations of a few weeks at a time and excess heat of up to 70% above the calibration curve appears to be present in most cells when the input joule power is in the 80 to 120 mw region. The current density at the optimum regime is in the region of 1 - 2 mA/cm^2 (with respect to geometrical area).

Electrolyte samples before and after electrolysis were analyzed for tritium content following micro-distillation to eliminate chemiluminescence effects. Samples from 6 out of 12 experiments analyzed have indicated tritium levels varying in the region of 46 Bq/ml (11 times control value) to 3389 Bq/ml (734 times control value). All three runs with Li_2CO_3 + 100% H_2O (13 to 20 days of operation) have yielded tritium (279 Bq/ml to 1454 Bq/ml). The generation of tritium in cells containing only H_2O is a surprising new finding. However the highest tritium value (3389 Bq/ml) obtained to date is with a K_2CO_3 + 25% D_2O case. No clear cut correlation between excess heat and tritium has emerged so far. But it is apparent that tritium producing reactions cannot account for the tens of Kilojoules of excess energy generated over a period of several days.

Experiments are presently underway to eliminate possible loopholes in the calorimetry and also to confirm that the excess heat is not due to partial recombination of electrolytic gases and that the tritium is not due to contamination from the electrodes or other cell constituents.

EDITOR'S COMMENTS

Dr. M. Srinivasan presented an excellent review of experimental results from three different groups within BARC, all of whom were experimenting with light-water cells using various alkali-metal compounds in the electrolyte. One of the slides shown was a photograph of a nickel cathode in which finger- or thumb-prints were clearly visible. This cell was one of the few light-water cells that did not produce excess heat. This disclosure is another important emphasis that all materials that go into cold fusion cells should be kept clean.

The cell structure used a flat plate of porous nickel for the cathode. Reverse polarity current was used for calibration purposes in some cases. Excess heat was measured with lithium, sodium, and potassium carbonates using both light water and mixtures of light and heavy water. Tritium was only reported if the measurements were greater than two times background. Only 1 out of 18 cells failed to provide excess heat (contaminated cathode). Seven of eleven cells produced tritium. Some of the cells were operated using intermittent d.c. current with on-line measurement of tritium.

We had the pleasure of meeting with Dr. Srinivasan this summer during a technical presentation here in the U.S. He had been impressed by the experimental work of Drs. Bush and Eagleton and with the extension by Dr. Bush of Bush's Transmission Resonance Model to include the light-water, nickel-cathode, alkali-metal electrolytes. *Fusion Facts* highly commends Dr. Srinivasan and his group for their excellent replication of this important new energy-producing electrochemical cells. [See also the report by Drs. Bush and Eagleton in this issue.]

ENGLAND - H/D IN PALLADIUM

D.R. Coupland, M.L. Doyle, J.W. Jenkins, J.H.F. Notton, R.J. Potter and D.T. Thompson, (Johnson Matthey Technology Center, Sonning Common, Reading, UK), "Some Observations Related to the Presence of Hydrogen and Deuterium in Palladium," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Surface and bulk analytical work carried out on rod samples returned to Johnson Matthey by Fleischmann and Pons indicates that a number of elements, including Pt and Li were deposited on the surface during electrolysis in D_2O. Surface analysis via time of flight SIMS indicates that the Li^6/Li^7 isotope ratio is unusually low but no original reference is available.

One electrolyzed rod exhibited recovery of part of the wrought microstructure which would ordinarily require a temperature larger than about 200°C, and another rod showed recrystallization of a portion of its length and this would normally require a temperature greater than about 300°C. These effects which were observed at the ends of the rods away from the spot welds cannot be readily explained by known processing history, and could not be reproduced by filing or sawing.

Temperature programmed hydrogen absorption/desorption profile measurements on a range of Pd samples indicates wide differences in properties; for example a rod electrolyzed in LiOH absorbed hydrogen more readily than a similar rod electrolyzed in NaOH. This technique would therefore seem to be of value in characterizing the Pd electrode.

Electrochemical measurements conducted in H_2O show that there are significant differences between the behavior of Pd in LiOH and in NaOH and KOH solutions; and hydrogen evolution/dissolution is subject to surface conditions on the Pd.

A detailed account of the work which led to the above conclusions will be given. SEM EDAX analysis profile plots for Cu, Fe, Zn and Pt percentages for various positions along the rod will be shown and the identification of elements on the surface using XPS analysis described. TOF/SIMS measurements were used to measure Pd and Li isotope ratios on the surface. The results of bulk analysis via spectrographic techniques and ICP will be indicated. The microstructural variations shown by the metallographic examinations will be demonstrated; and the technique of temperature programmed

reduction described and the most significant results discussed. Finally the results from electrochemical experiments in H_2O, which showed differences between the three alkali metals, will be considered.

EDITOR'S COMMENTS

It was reported that Pd rods had cracks and scratches that increased in terms of the increased current density used in the experiments. Rods that undergo electrolysis were contaminated with Fe, Cu, Zn, and Pt on or near the surface. It was especially noted that the Pt deposition seemed to increase with current density. [Note that Dr. Robert T. Bush has reported that the build-up of Pt is essential to the successful operation of a Pd cathode cell.] It was also reported that the depth of the contamination is also a function of the current density. A rod with 64 mA per sq cm had elements to a depth of 300 Angstroms and a rod exposed to 512 mA per sq cm had elements to a depth of 1800 Angstroms. There appeared to be a reduction in the ^6Li isotopes suggested that some isotopic shifts are occurring. This finding supports Dr. Bush's (and others) model that cold fusion is an alkali-metal/hydrogen fusion. The authors showed photographs of two used Pd rods where one skilled in the art could perceive that the rods had achieved temperatures well in excess of what would be expected during ordinary electrolysis -- suggesting, of course, that something other than normal electrolysis was taking place. As a result of some experimentation using Pd in LiOH, NaOH, and KOH, the authors suggest that LiPd alloys should be used experimentally to determine if better results would be achieved.

SPAIN - CF USING TITANIUM

B. Escarpizo, J.F. Fernández, F. Cuevas, J. Tornero, and C. Sánchez (Dpto. Física de Materiales C-IV, Universidad Autónoma de Madrid, Spain), "Deuterium Concentration Profiles and Crystallization Anomalies in Electrolytically Deuterated Titanium Plates," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

It has been emphasized by different authors that two conditions, at least, must be fulfilled if room temperature nuclear fusion reactions in deuterated metals are to be expected: very high deuterium concentrations (i.e. D/Ti≥2, D/Pd≥1) in the metal lattice and some (external or internal) factors that stimulate non-equilibrium situations in the deuterated matrix. Following with our program to study some solid state phenomena associated with Cold Fusion we have investigated deuterium concentration profiles (variation of D-concentration with depth) and some crystallization anomalies in electrolytically deuterated Ti plates. Ti plates (~1.5x1.5x0.1 cm), used in several electrolytic cold fusion experiments (>1000 h, different current intensities and electrolytes) have been investigated. "Post mortem" deuterium concentration profiles have been obtained by Elastic Recoil Detection (ERD) and crystalline structure of the plates determined by X-ray diffraction (XRD) as a function of the plate depth. It has been found that D-concentration remains practically constant (D/Ti ~ 1.65) up to depths ~100--110 μm and then it decreases to D/Ti~0.05 in about 15-20 μm. For higher depths and up to ~200 μm the ratio D/Ti slowly decreases from ~0.05 to 0.00. This behavior seems to be related to the (alpha+gamma) to gamma phase transition and to the grain structure of the Ti plate. In relation to the formed deuteride crystallization it has been found that some planes, mainly (111) and (222), of the cubic lattice become preferred at depths ≥20-30μm. This singularity seems to be due to an irregular crystallization of the original Ti plates which present a predominant crystallization of the (002) Ti face at the same depths. As it can be shown, both the (222) planes of the TiD_x cubic lattice and the (002) of the Ti hexagonal crystals, are the planes of higher packing. Possible connections of the former experimental results with reproducibility of Cold Fusion experiments are discussed. This research has been supported by CICYT (Spain) under contract NAT90-0053. Support received from Fundación Banco Exterior (FEB), Madrid, is also gratefully acknowledged. ERD measurements were performed at LNTI (Lisbon, Portugal).

EDITOR'S COMMENTS

Dr. Sánchez reported on 20 experiments lasting over 2,000 hours using titanium plates. A part of the experimental findings were that the D/Ti ratio varied strongly with depth into the titanium lattice. This finding suggests a slower transportation of deuterium into the titanium lattice as compared with a palladium lattice. Dr. Sánchez properly considers that the future development of cold fusion could benefit by the use of less expensive materials than palladium. A few researchers have shown some excess heat using titanium cathodes in an electrochemical cell. We commend Dr. Sanchez on his experimental work with titanium.

FRANCE - CELLS BOIL OFF!

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.

AUTHORS' ABSTRACT

The main objective of this presentation will be the illustration by means of time-lapse 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 (greater than 1 Kw per cu cm); 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 points for further research provided by the video recordings of these experiments.

EDITOR'S COMMENTS

The latest dewar containers have silvered mirror-like surfaces to the top of the cells. Open cells with uniform current density are used. The liquid level is topped off on a scheduled basis to make up for liquid lost through electrolysis. Cells are calibrated and run for up to 700,000 seconds (a little over 8 days). Blank cells are used using LiOH or Pt cathodes with LiOD. Large bursts of heat were first noted in 1989 with the excess enthalpy being extremely large - into the megajoules. Experimental work has involved looking for sustained power gain. Experiments are run near the boiling point of the solvent. The procedure is to charge or load at low temperatures and then run the cell at higher temperatures with usually a single pulse of voltage change [from low charging current to a higher operating current.] Video time-lapse techniques are used to monitor the cell operation so that when the cell "**turns on**" the video can be used to observe and compute the total energy as the hot cathode boils off the electrolyte. Dr. Pons pointed out that only vapor and not mixture of gas and liquids is boiled out of the cell, therefore it is relatively easy to compute the energy being provided by the "**turned on**" palladium-alloy cathode.

The video presentation was shown. Four cells were in view and as time elapsed, each of the cells achieved a state in which the heat generated from the cathode caused rapid boiling of the electrolyte. In each of the four cases the liquid was completely boiled out of the cell leaving only a film of residue on the interior of the cells. The video was most impressive. The cathodes were a standard size of 1.25 mm in diameter by 1.4 mm long. A Kel F stopper was used. Lab film was used to wrap the stopper in the dewar cell. The current was reported as being 200 mA at the low level and 400 mA at the higher level used after loading. The excess enthalpy was 86,700 Joules with the excess power being 144.5 watts or 1,800 watts per cu cm of Pd (or Pd alloy). The volume of the Pd was reported as 0.0785 cu cm.

Dr. Nate Hoffman asked if the effect was surface or volume. Dr. Pons said that the evidence points to a volume effect for their work. Dr. Scott Chubb asked about the rate of success. Dr. Pons stated that for a given batch of cathode material if one piece did not load and "work" then the entire batch could be expected not to work and the converse. [Apparently the metal processing techniques are yet to be completely specified so that the same effect can be achieved with various batches of cathode material. Pons reported that the loading of the cathode is a strong function of charging cycles and temperature. Pons reported that they had not verified isotope shifts (such as of ^6Li). He also reported that the electrodes reached a temperature of at least 240 deg C.

Fusion Facts is most pleased with the current successes of Drs. Pons and Fleischmann. Since July 1989 when we issued our first press release we have applauded the work of these scientists and made the declaration that the science is real and has commercial potential. We rejoice in the ongoing good work of these cold fusion leaders and wish them continued successes.

FRANCE - CAPILLARY FUSION
Courtesy of the author.

Jean-Pierre Vigier (Univ. P. and M. Curie, Paris), "New Hydrogen Energies in Specially Structured Dense Media: Capillary Chemistry and Capillary Fusion," Preprint courtesy of the author, to be published in *Phys. Lett. A.*

AUTHOR'S ABSTRACT

The analysis of presently observed facts suggests that excess heat (above break-even) and concomitant cold fusion processes result from two different mechanisms which have a common origin in e.m. current behavior in dense media (the Ampere forces). They both result from already known properties of nuclear forces and quantum mechanics.

AUTHOR'S INTRODUCTION

[Excerpts] ...growing evidence of new phenomena, tied to the presence of hydrogen and deuterium, in various types of electrodes. It can now be stated:
A. [Pons-Fleischmann claims verified]
1. in electrolytic heavy water... 2. in Pd plates coated with Au and MnO ... 3. in glow-discharge deuterated Pd ... 4. in Tungsten bronze ... [in light-water electrolysis. Ed.]

B. The observations of very small quantities of "fusion ashes" ...but the essential fact remains:
1. ...known fusion reactions .. [do not] explain the observed excess heat.
2. ... no possibility to explain... overcome their Coulomb repulsive barrier ...

3. ... an apparent correlation between neutron ...with this excess heat ...

C. That the excess heat ... utilizing hydrogen and ordinary light water. ... implies the appearance of a new still unknown chemical type of phenomena ...

The facts A) B) c) evidently imply the following: 1. Where does the heat come from ...? 2. Why ... not always reproducible ...? 3. Why is there a delay in time? 4. What is the origin ... of bursts? Why are they correlated with neutron bursts? 5. If excess heat does not come from fusion and/or known chemical reactions ... what is its nature ...?

AUTHOR'S CONCLUSIONS

From this too brief analysis one can devise some experimental proposals and recall two quotations:
A) New experiments are urgently needed.
1) Redo all experiment presented here with heavy and light water (or with hydrogen and deuterium).
2) Look at clustering theoretically and experimentally and look for radiation emitted by excited H_{2+} and D_2+.
3) Push forward microscopic structural analysis of palladium bronze, etc. to look for capillaries (seen in bronze by Kabir) and compare systematically successful and unsuccessful samples.
4) Try high current intensity very short current discharges in various situations (in conducting fusion material) to see if they increase excess heat production using loaded electrodes to increase the effect.

B). a big theoretical open minded effort is evidently need
1) As stated by Einstein, *"Humanity is, with respect to modern science, like an inexperienced horseman on a wild horse."* Evidently the wild horse of cold fusion has left the stable and is presently running.
2) As stated to me long ago by Yukawa himself, *"When new facts appear the true theoretician should adapt his theories to these facts not the reverse." We are still far from a correct disentanglement of facts in condensed matter.*

TAIWAN - NEUTRON MONITORING

L.J. Yuan (Inst. of Nuclear Science), C.M. Wan, C.Y. Liang, & S.K. Chen (Materials Science Center, National Tsing Hua Univ.), "Neutron Monitoring on Cold Fusion Experiments," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

Neutron monitoring systems were equipped with two different types of experiment to collect continuously the information of possible neutron production during the electrolysis process. The first type of experiment was the Pd-D_2O of 0.1 M LiOD electrolytic cell. In this experiment, two types of monitor were equipped. They are the helium-3 proportional neutron detector and the hyper-pure germanium high resolution gamma ray detector. The helium-3 detector was used directly to collect both the neutron emission rate as well as its energy. The hyper-pure germanium detector was used to monitor neutrons indirectly from the measurement of gamma ray which was generated by the interaction of neutrons with the cell itself and its surroundings. These interactions include H(n,7)D reaction of emitting 2.223 MeV prompt gamma, Fe(n,n') inelastic scattering of emitting 648.7 keV gamma ray, and B(n,α) reaction of emitting 477 keV gamma ray.

The second type of experiment was the **Liaw-type electrolytic cell contained eutectic LiCl-KCl molten salt saturated by LiD electrolyte**. In this experiment, only helium-3 neutron detector was equipped to monitor both the neutron emission rate and the energy distribution.

For long-time monitoring of the Pd-D_2O cell in electrolytic process, the neutron level was statistically 20 to 30 percent higher than the background level, depending on the controlled cell temperature (from 15 C to 50 C). From gamma spectroscopic measurements, there is no sufficient information which can support the existence of H(n,gamma)D, Fe(n,n'), and B(n,α) reactions, because the level of these interactions was below our detection limit.

For running the Liaw-type cell, the neutron counting rate increased about twice above that of the background measurement. A large number of neutrons with energy ranging from thermal up to 350 keV were recorded by the pulse height signal in the multichannel analyzer, while there was insufficient data to prove the existence of neutron energy higher than 350 keV.

EDITOR'S COMMENTS

Dr. Chen, who presented the paper, reported that the neutron count output went up when the power increased. The graph of the output (temperature versus time) appeared like a range of hills with some increasing peaks over time. The output could be caused by a series of bursts lasting over significant time periods. Chen reported that the d.c. background changed after 1 to 12 watts [power generated]. The eutectic molten salts experiments used a Pd cathode 6 mm in diameter in an Al vessel. A smaller Pd rod of 22 mm diameter showed a 10-hour burst of heat. These experiments replicated the Liaw work and on at least one occasion the excess heat was 100 times the input power.

RUSSIA - GLOW DISCHARGE HEAT

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.

AUTHORS' ABSTRACT

Spectrometry of gamma-emission from glow discharge in deuterium with Palladium, Niobium, Zirconium and other cathodes were 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 (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-line was 10^2 to 10^5 per sec. 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-quanta with anisotropy over the 4 pi solid angle can be seen. Beam divergence is less than 0.1 degree. The existence of this beam can affect the accuracy of the spectroscopic measurements.

[1]. A.B. Karabut, Ya.R. Kucherov, I.B. Savvatimova, "Nuclear Reaction at Gas Discharge Cathode," *Sov. Techn. Phys. Letters*, vol 16, No. 12, 1990, pp 53-57.
[2]. A.B. Karabut, Ya.R. Kucherov, I.B. Savvatimova, "The Investigation of Deuterium Nuclei Fusion at Glow Discharge Cathode," *Fusion Technology*, vol 20, No 4, part 2, 1991, pp 924-928.

EDITOR'S COMMENTS

In previous reports on Karabut et al. work on low pressure deuterium gas, excess heat of up to 150% was reported. In their latest work, the authors report excess heat up to 500% in addition to considerable neutron flux. In the conference, we failed to get much more information. We look forward to reviewing a copy of this paper. Karabut did say that if the energy is low or if the charged particles are heavy that the nuclear reaction may occur within 0.1 to 0.2 microns of the surface. Voltages used in the glow discharge work range from 150 to over 500 volts. Dr. Nate Hoffman asked if it were possible to have obtained some palladium that had been contaminated by nuclear radiation. Kucherov stated not so and that tests had shown very low radiation prior to use in the glow-discharge equipment.

RUSSIA - OXIDE TUNGSTEN BRONZE CF

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.

AUTHORS' ABSTRACT

The possibility of essential increase of the rate of carrying out nuclear reactions with participation of deuterium in solids representing solid electrolytes with cation-electronic conductivity has been shown in the paper. It is found out that strict maintenance of experiment parameters leads to completely qualitatively reproduced results; generation of neutrons; and heat at introduction of deuterium into the system.

AUTHORS' INTRODUCTION

Beginning with the famous work of Fleischmann and Pons the investigators of anomalous nuclear phenomena in condensed matter did not succeed in getting 100% reproduction of ... emission of nuclear reactions products. All experiments were carried out with solids on the basis of a metal-hydrogen system. Neither the structure nor the crystallographic orientation were controlled. Unlike other experimenters, ... we used new materials: monocrystals of oxide tungsten bronzes (OTB) of non-stoichiometric compounds, having the general formula Na_XWO_3. The facet (100) of the crystal was selected as the working surface with the channels of rigid W-O sublattice being perpendicular to this face. Alkali metal cations can be introduced and can move in these channels. Depending on the content of the alkali in the OTB and the resulting change of valent state of tungsten in the sublattice W-O, electronic conductivity of OTB can vary greatly. This feature allows one to create structures with high gradient of composition and therefore changes in the observed properties. [Some editorial changes from the original. Ed.]

EDITOR'S COMMENTS

In his presentation Kaliev stated that it was not cold fusion but it was a nuclear reaction within these single crystal tungsten bronze materials. The channels that the H or D enter are in the structure of the oxide bronze. He noted that when the channels are in metal then the nuclear reaction activity is greatly increased. The single crystals are 1 to 2 mm in size. The paper describes briefly the steps in heat-treating the crystals prior to cooling and introduction of H or D. The observed increases in neutron output and in increased heat is highly reproducible (at least to one skilled in the art.) Up to 50 degrees C temperature rise has been observed. Over 150 experiments have been performed. In his conclusions, Kaliev noted the following: 1. This work fully proves the presence of nuclear reactions. 2. The reproducible phenomena can be predicted within 1 minute accuracy. 3. The heat of the deuterium reaction is larger than when using hydrogen with a reaction magnitude of about 50 watts [presumably per each 1 to 2 mm crystal]. In the question period, Dr. Vigier suggested the use of a laser to see what happens in the capillary channels. Kaliev mentioned that there was significant heat increase even with the use of hydrogen. Kaliev reported that they have been doing work for over one

year using hydrogen but has only used deuterium gas since September. In his paper, Kaliev computes the probability of fusion events leading to the neutron flux as being about 2 x 10^{-18} neutrons per second per D-D pair. This lambda is about 20 orders of magnitude larger than has been calculated as being possible for D-D fusions in a Pons-Fleischmann type cell. [This report is the first that *Fusion Facts* has seen for this type of single-crystal structure. As the authors state this type of experiment is expected to lead to a better understanding of the mechanism for the fusion phenomena. THEORISTS PLEASE NOTE!]

RUSSIA - REVIEW OF WORK

By Dr. Vladimir A. Tsarev

Presentation made on October 25, 1992 the last day of the Nagoya Conference, Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

EDITOR'S REPORT

Dr. Tsarev is with the P.N. Levedev Physical Inst., Academy of Sciences, Dept. of Nuclear Physics and Astrophysics in Moscow. Tsarev is an excellent artist and had some entertaining cartoons to depict the past and present state of both cold fusion and the "particles emerging from the former USSR" [breakaway countries.] A year ago at Como, Tsarev reported on 80 papers from 45 institutes and labs. This year there are 25 papers and fewer laboratories involved in research in cold fusion. He cited the value of a book, Hydrogen Chemistry and Technology, which was issued November 26-28, 1991 (probably a proceedings) as being an important resource. Dr. Tsarev mentioned the work that Kaliev et al. are doing using tungsten bronze and the difference in neutron measurements using that material with hydrogen (no neutrons) and using deuterium (neutrons at 2 to 20 times background.) This work appears now to be 100% reproducible. Also the nuclear products and excess heat in the glow discharge experiments is highly reproducible. Excess heat of as much as 500% has been achieved. Many charged particles are produced that are apparently rich in spectra. Signals persist after the voltage is off. There may be an interesting phenomenon in the way that energy is emitted: evidence that the energy is beam-like and this may explain widely differing results. (If the beam hits the measuring equipment or misses the sensors.) Tsarev mentioned the urgent need for reasonable models to improve our understanding of the nature of CF and to improve our experimental designs. Some comments were made about a nonstational or violation of stationarity in solid state devices. Barrier penetrability by high momentum should be considered. Ionization and phase transitions (e.g. D_2 to 2 D^+) should be considered. He concluded with the emphasis on the importance of improved models.

ITALY - MULTIPLE CELL TESTS

D. Gozzi, P.L. Cignini (Univ La Sapienza), R. Caputo and M. Tomellini (Univ di Roma) E. Cisbani, S. Frullani, F. Garibaldi, M. Jodice and G.M. Urciuoli (Laboratorio di Fisica, Istituto Superiore di Sanita and sez. Sanita INFN, Roma), "Experiment with Global Detection of the Cold Fusion Products," Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

AUTHORS' ABSTRACT

On the line of the previous experiments [1-3] carried out in a multicell electrochemical system, we will discuss the results obtained with an improved experimental apparatus recently assembled. In the present experimental configuration, we have a 60 ^{3}He tubes neutron counter from Jomar/Canberra (Los Alamos, NM) in which the ten cells system is located. In this way the efficiency of the neutron detection has been increased from $5x10^{-5}$ to 0.2. The sixty tubes are divided in twelve groups allowing to localize which cell is generating neutrons owing to the counting of the twelve separated scalers. As reported in the literature [3], each count is dated, now with the microsecond accuracy, and stored and pulse shape discrimination is done off-line. Due to a proper electronics we have now the potential to detect the time structure and multiplicity of burst-like events. ^{4}He determination by mass-spectrometry is another feature recently added to our experiment. By a home-made device, we hope to feed the mass-spectrometer inlet by a deuterium free gaseous mixture coming from the electrolysis. At present time, our experiment allows to measure in ten equal cells the following quantities: i. Excess heat; ii. Tritium in solution and in recombined gases; iii. Gamma ray; iv. Neutrons; and v. Helium. Some of these quantities were successfully detected in the previous experiment. We are moving with a new experiment in which particular attention has been paid to the Pd metallurgy. These results, if obtained, will be shown at the Conference. We will also discuss the result of the final analysis of the neutron data of the experiment performed last year in which we have some indications, through the pulse shape analysis, of a correlation between some burst-like events and excess heat.

[1]. D. Gozzi et al., AIP Conference Proceedings 228, *Anomalous Nuclear Effects in Deuterium/Solid Systems*, Provo, UT, October 22-24, 1990 (Eds. S. Jones, F. Scaramuzzi and D.Worledge), American Institute of Physics (New York) 1991, p. 481-493.

[2]. D. Gozzi et al. *J. Fusion Technology*, 21 (1992) 60-74.

[3]. D. Gozzi et a/., "Multicell Experiments for Searching Time-Related Events in Cold Fusion," Proc. 2nd Intl. Conference on Cold Fusion, Villa Olmo, Como, June 29 - July 4, 1991, Conference Proceedings Vol.33, Societa Italiana di Fisica, Bologna (1991) 21-47.

EDITOR'S COMMENTS

Dr. Gozzi showed pictures of the experimental area and the ten cells undergoing experimental processing. In cell #7 excess heat was produced of the order of megaJoules. In a 15-day

period they measured 8 big bursts of neutrons with multiple counts greater than 40 neutrons which were correlated with excess heat. They are set up to measure helium and tritium but as yet have not detected helium. The authors conclude that the neutron count is correlated with the generation of excess heat. Bursts of neutrons show that there are more than single nuclei involved. Dr. Vigier suggested that there may be local concentration of material that supports the nuclear reactions.

ITALY - REVIEW OF WORK
By Dr. Scaramuzzi

Presentation made on October 25, 1992 the last day of the Nagoya Conference, Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

EDITOR'S REPORT

Dr. Francesco Scaramuzzi is with ENEA in Frascati, Italy. His first comments were on the strange geography of cold fusion: Japan, Russia, China, and India appeared to have a coordinated effort in cold fusion with some degree of official respect. The United States, except for EPRI's funded research is working under a negative official position by the government. In Europe, except for Italy and Spain there appears to be little CF effort and a negative official position. In Italy there is good CF work at INFN (Nat'l Inst. for Nuclear Physics), CNR (Nat'l Research Council); ENEA (Agency for New Technology, Energy, and Environment); a few Universities; and some Industrial work. The total expenditures on CF in Italy are estimated to be about $0.5 million, not including personnel. Most of the activity stems from educational institutions such as Univ of Roma together with Frascati; Univ. of Torino; Univ. of Milano; and Univ. at Catania. Three groups are working on excess heat; 3 on gas loading; 4 on tritium; and 2 on electrolysis. Four others are doing some combination such as gammas and neutrons. At Padova there is some interesting work using CR-39 and finding 10,000 tracks per sq mm per hour. As with other researchers they find that the type of treatment of the palladium (either after or before received) strongly affects the results of the experiments.

CHINA - REVIEW OF WORK
By Prof. Xing Zhong Li

Presentation made on October 25, 1992 the last day of the Nagoya Conference, Presented at the Third International Conference on Cold Fusion, October 21-25, 1992, Nagoya, Japan.

EDITOR'S REPORT

Prof. Xing Zhong Li is from the Tsinghua University in Beijing, China. Some modest funds are provided by the State Commission of Science and Technology and by the Natural Science Foundation of China. The number of teams that are working on cold fusion has reduced but the quality of the work has improved. The following institutions are involved in cold fusion research: Sichjuan Inst. of Materials and Technology (neutrons); Inst. of Applied Physics and Computational Mathematics (neutrons); Inst. of South West Nuclear Physics and Chemistry (neutrons); Tsinghua University (theory); South West Inst. of Physics (theory); Inst. of Atomic Energy (theory); Beijing Normal Univ. (theory); Xiamen Univ. (Helium); Chengdu Univ. of Science and Tech (Heat); Inst. of Chemistry (Space Field Theory of Thermodynamics); and Univ. of Science and Tech. of China (charged particles). Experiments are being run with several kinds of electrodes in high voltage (17 kV - not cold fusion). Highest peak for particles measured is about 10 MeV. Work is being done with niobium and the neutron count is one per minute using H but increases to about 2 per second using deuterium. A new theory about Coulomb barrier penetration involves the concept of combined resonance tunneling. Some of the scientists are beginning to look at cold fusion as being solid state nuclear physics in which a film of metal is essential. The mechanism could involve combined resonance tunneling, a semi-resonance level; and both meta-stable and excited deuterium atoms. Comments by Dr. Scott Chubb concerned the 17 KeV work and that the phenomena that is being investigated is expanding, "lots of things going on."

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2 SKEPTICS - SWITZERLAND & NEW YORK

FIRST SKEPTIC (Oral Presentation)
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.

AUTHOR'S ABSTRACT

Cold Fusion is defined. The Cold Fusion reactions are listed and previous experimental results are presented and discussed. The requirements of satisfactory experiments for calorimetric measurements and for measurements of fusion products (neutrons, protons, tritium, helium, gammas and X-rays) are given. Thus for calorimetric measurements, the cleanest experiments use closed cells in a nest of constant temperature baths with heaters so that the experiment is a classic null-point one as the Wheatstone bridge; it is possible to use an open cell without such surrounding baths, but the calibrations and corrections required are numerous. For neutron measurements, a redundancy of counters is essential and special precautions are needed to avoid counting gammas; the most sensitive measurements are those performed underground with adequate shielding, in particular inside the Kamiokande detector. The main experimental results are reviewed, both those claiming positive results and those claiming null effects. It is seen that the results are contradictory. In fusion studies it is always possible to measure several quantities simultaneously and the experiment which obtains both qualitative and quantitative agreement tends to be accepted. For example, when tritium is

produced, so are protons of 3 MeV and such protons in stopping in a metal, produce characteristic X-rays - the simultaneous measurement of these and of tritium in comparable quantities would be strong evidence in favor of Cold Fusion. At the time of writing, August 1992, the balance of experiments indicates no compelling evidence for the existence of Cold Fusion effects. Proposals for future experiments are made.

SECOND SKEPTIC (Poster Session)
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.

AUTHOR'S ABSTRACT

In March, 1989 two strikingly different claims were advanced for room temperature nuclear fusion. Fleischmann and Pons reported watts of excess power and Jones et al. reported neutrons at very low intensities, at a level many trillion times smaller than the excess power. The time has come for everyone both to recognize and to acknowledge that there is no evidence to support any relationship between these two claims and that claims of low-levels of fusion products do not confirm the nuclear origin of watts of excess power. If nuclear reactions are the source of watts of excess power, it follows from very basic and general principles that nuclear-reaction products must be formed in intensities of the order of 10^{12} per sec. The sensitivity for detecting nuclear-fusion products is orders of magnitude greater than that for excess power. Therefore, serious claims of nuclear fusion-produced excess power must be accompanied by commensurate intensities of fusion products. More than three years have elapsed and still no such experiment exists. [The author is seriously behind in his literature studies. - Ed.] In order to eliminate artifacts and to increase the credibility of claims of low-level fusion products, it is necessary both to use redundant detectors and to measure simultaneously two or more fusion products. This is especially necessary for ^{4}He and T where backgrounds continue to plague all reported measurements. The present evidence for the discovery of a new nuclear process termed cold fusion is still not persuasive.

EDITOR'S COMMENTS

It is amazing that these two brilliant, famous, and likeable gentlemen can be so perennially capable of overlooking the enormous amount of evidence in favor of cold fusion. Dr. Morrison's presentation seemed to be a struggle to convince anyone who would listen that cold fusion experimenters are incompetent. With over 300 scientists, who have had successes in cold fusion experiments, as his audience, Morrison found only Huizenga in agreement. It was a poor performance for such a brilliant scientist and a waste of valuable conference time.

E. NAGOYA PANELS

PANEL ON TAKAHASHI EXPERIMENT

Akito Takahashi (Osaka U.), Makoto Okamoto (Tokyo Inst. of Tech.), Eugene Mallove (Clustron Science Corp, Virginia), Francesco Celani (Lab. Nazionali Frascati, Italy), and Antonella de Ninno (ENEA, Frascati, Italy) were the panel members. Topic: "Panel Discussion on the Takahashi Method."

EDITOR'S REPORT

TAKAHASHI: Dr. Takahashi made a short presentation on his method. A Pons-Fleischmann type electrochemical cell was modified to use a flat plate of Pd surrounded by a rectangular spiral of Pt wire spaced about 1 mm from the Pd. During electrolysis the current was changed from a low current mode to a high current mode with a cycle time of about 6 hours. Over a period of about seven days considerable excess heat was generated. In addition, neutron flux was monitored. A correlation between heat and neutron flux was established. Energy was measured that was about 1,000 times more than could be attributed to chemical reactions.

CELANI: Dr. Celani reported on replications of Takahashi in which flow calorimetry was used. Four specimens were used with one being a blank or control. The results were that 25% excess heat was observed for a short time. Celani reported, "If you don't get overvoltage, you don't get excess heat."

OKIMOTO: Dr. Okimoto reported that with three Pd samples, 2 did not work. The other sample produced excess heat. He showed that neutrons were produced when the current density was about 200 mA per sq. cm but that neutrons were not produced at current density of 10 mA per sq. cm. He stated that the Low/High current cycling was effective in producing neutrons. He concluded that high concentration of deuterium in the Pd is necessary and that the High/Low current technique is effective.

MALLOVE: Dr. Mallove reported on his experimental work which was conducted in his own basement in Bow, New Hampshire. He had a Pd sample which was from the same batch as Takahashi original Pd cathode. It has been found that another Pd sample from the same supplier but a different batch did not provide excess heat. [See the report by Dr. Storms (under New Mexico) where the two different batches are carefully examined. The treatment of the second batch caused sufficient cracks so that it was deemed unlikely that the palladium lattice could load sufficiently to be an effective cathode in a cold fusion cell.]

DE NINNO: Dr. de Ninno reported on the confirmation of excess heat using the Takahashi method. She used a cell configuration in which one side of the Pd was facing deuterium gas and measurements were made of the change in gas pressure. Her experiments showed that they had best results when the square wave period was from 190 mA to 40 mA with about a 4500 second cycle time. They ran the experiments for 280 hours. Her conclusions were that excess heat was confirmed; the D/Pd ratio is important; and it is important to understand the kinetics of the gas.

DISCUSSION: Dr. Ikegami asked the reason for trying the High/Low current. Dr. Takahashi said that he was looking for neutrons and decided to see what pulsing the current might do. Celani said that he tried 12-hour periods but found that a 40-minute square wave was better. He thought the cycle time might depend on the Pd sample. Dr. Nate Hoffman pointed out that the Joule effect expansion heats (not cools) palladium. He asked about a possible thermo-electric effect. Dr. de Ninno said that it was the same for all cells (control and other). Jerome Drexler asked if anyone had introduced a third electrode so that the voltage could be changed but that the current would remain the same. No one responded. A question about recombination of evolved gases was asked. Dr. Mallove answered that the data from his closed cell was conservative because the possible heat loss through the loss of some leakage of H_2 and O_2. Mallove also reported that he did vary temperature and that such changes may have interfered with accuracy of measurements. In his second experiment, Mallove used palladium from the same "second batch" that Storms had also received and that his results were negative with that piece of palladium. Dr. Scott Chubb asked about the degree of loading. Dr. Celani showed a chart indicating they had achieved loading of 0.74, then switching the cell "OFF" and "ON" they achieved 0.84 loading and got excess heat. Celani reported that if you "do something wrong" the palladium has a memory and it takes some time to recover.

PANEL ON THEORY

Peter L. Hagelstein (Research Lab of Electronics, MIT), Giuliano Preparata (Univ of Milano, Italy), Vitaliy A. Romodanov (Head Engr SRI, SPA "Lutch", Russia), and Jean Pierre Vigier (Lab Physique Theorique, Univ P. et M. Curie, Paris) were the panel members. Topic: "Panel Discussion on Theoretical Model."

EDITOR'S REPORT

HAGELSTEIN: Dr. Hagelstein briefly presented his latest theory. The theory combines the concept of virtual neutrons, gamma emission induced by d.c. fields, and the calculation of reaction rates. To these concepts he has added new physics involving a change in the center of mass of the lattice with a possible acoustic and optic branch in the release of photons. Dr. Hagelstein is finishing the fourth paper to complete the description of his new theory. In a personal discussion Hagelstein related that he is most pleased with his theory and believes that he has provided a substantial contribution to the understanding of some of the cold fusion reactions and the production of excess heat.

PREPARATA: Dr. Preparata states that the theory of cold fusion must be encompassed by Generally Accepted Condensed Matter Physics. The plasma of the Pd lattice plus the plasma of the deuterons must be considered together with the electrons and the interaction with macroscopic coherent magnetic fields. "Little balls of Condensed Matter" is a phrase used by Preparata. The plasma frequency, oscillating in phase, in a coherent quantum plasma. Under appropriate conditions one can realize an energy gain with respect to an incoherent state. Some progress has been made on describing and sizing a coupling constant that must exist between the plasmas. Under proper conditions both plasmas can be coherent. There can be two deuteron plasmas, one occupying the octahedral sites and the other the tetrahedral sites. [Dr. Preparata worked on this cold fusion theory while a visiting professor at the National Cold Fusion Institute and has been improving it since. The theory provides some insights into the fusion of deuterons in a lattice. There is some evidence that the primary nuclear reactions may include d + ^{6}Li. We would like to see this issue addressed by Dr. Preparata.]

ROMODANOV: Dr. Romodanov read his brief paper [see the abstract and comments under RUSSIA - GLOW DISCHARGE C.F.]. Romodanov has been working with glow-discharge pressure regime using palladium cathode and a few hundred volts of input power. The experimental results show the previously discovered unexpected low ratio of neutrons to tritium (of the order of 1.1×10^{-6} to 2.1×10^{-4}). Tritium as high as 9.6×10^5 atoms per second was produced. The amount of tritium generation apparently goes up with the bombardment time. [During the afternoon poster session, we heard an interesting comment made by Dr. Yan Kucherov to Dr. Romodanov, both of whom are from the Moscow region of Russia: "To think that I had to come to Japan to find out that we are doing similar work." This comment reveals how important it is to provide conferences and other means of close communication among scientists working in this important new science of cold fusion.]

VIGIER: Dr. Vigier mentioned the work done with electrical discharges in water that proved capable of propelling water slugs with sufficient energy that the water slugs pierce steel plates. Vigier cites evidence for strings of current beads within long capillary-type conductors. This work is cited from papers in Physics Lett A on capillary fusion. [See the review of a paper by Vigier under FRANCE - CAPILLARY FUSION] Vigier reports that energy can be borrowed from spin energy within 3 fermis. In his conclusions Vigier provides the following:

1. Experiments should continue using both light- and heavy-water.
2. Look at the clustering.
3. Analyze the palladium.
4. Compare the successful and the unsuccessful experiments.
5. A big theoretical effort is needed.

In his final comments Vigier states that the theory must be adapted to the facts and not the opposite.

During the brief question period, Vigier stressed that we must now admit that both heavy- and light-water produce anomalous results. Dr. Rambaut mentioned that we should look carefully at the evidence for capillary fusion. Dr. Scott Chubb emphasized that some of our conceptions of what can happen in metal hydrides are not correct. He asks us to consider, "Where

are mistakes being made?" The Coulomb barrier is a misconception. We need to determine what is the triggering mechanism. Finally Chubb re-emphasized how loading in Pd cathodes is a key issue. Dr. Robert T. Bush asked if the observed beads in capillary fusion could be similar to the electron beads discovered and embodied in several patents by Kenneth Shoulders. The question was not answered. [Most of the articles about Ken Shoulders electron beads have appeared in *Fusion Facts*. Those who are not *Fusion Facts* readers would be unlikely to be familiar with Ken Shoulders' work. As Dr. Chubb states, the Coulomb barrier is a misconception as has been thoroughly demonstrated by Shoulders' work.]

The panel presentations used much of the allotted time and there was little time for questions. In summary, there are some excellent scientists doing highly creditable work on models and theories. Among those present, but not represented on the panel, were Chubb & Chubb, Robert T. Bush and others. One of the most predictive MODELS has been the TRM as it has been developed by Bush and the important verification of many of the TRM predictions as shown experimentally by Bush and Eagleton. There is no question but that the interchange among scientists at conferences like this and the rapid publishing and dissemination of information about experimental results are a strong need for modelers and theorists. *Fusion Facts* has tried to play a role in early dissemination of experimental results and asks all of our readers to share your experimental findings with us for rapid distribution.

THE FINAL ROUND TABLE
What we should do next.

This final round table consisted of the following: Dr. Michael McKubre (SRI, California); Dr. Eiichi Yamaguchi (NTT, Tokyo); Prof. Tsong Pyng Perng (National Tsing Hua Univ., Hsinchu, China); Martin Fleischmann (Univ of Southampton, England); Prof. Akito Takahashi (Osaka Univ, Japan); Prof. Steven Jones (BYU, Provo, Utah); Prof. Tulio Bressani (INFN, Torino, Italy); Dr. Peter Hagelstein (MIT, Boston, MA). Each panelist made a five-minute summary presentation: The question is: What should/would be the next step?

Dr. McKubre: It is obvious that we [scientists collectively] are doing something right. What is it? What have we learned? What experiments do we do next? What is the next step? He strongly suggested that we need **Collaboration, Cooperation and Correlation** (Quantified and temporal). We need to determine the cause that lead to experimental effects including the nuclear by-products. Experiments need to deal with the measurement of multiple variables. Care should be exercised to determine the "concentration of other species participating in the reaction."

SRI, International expects to be studying the loading of palladium cathodes. We can learn from null results. We must determine the correlation between the excess power and the D/Pd ratio.

Prof. Fleischmann: We observe excess power, it is no mystery. He commented that experimenters should listen carefully to what Pons-Fleischmann and McKubre have reported [especially as related to loading, use of low current/low temperature, and then raising both temperature and currrent.] "Cram D into the cathode; get the lattice into endothermic region [a measure of adequate loading]; and let the temperature rise.

We need to learn a lot more about materials properties. This study will require systemic R & D. There is a lot of unevaluated data. Data sets should be carefully evaluated [specifically including data taken by Pons and Fleischmann in their experimental work.]

Dr. Yamaguchi: He summarized the tritium production. He stressed the need for *in situ*, real-time measurments. Charged particles need to be more carefully measured [including the energy spectrum.] It is important to find the microscopic mechanism[s] responsible for the heat and particle generation. We need to follow the pressure vs. neutron production. [Your editor misses the point of this suggestion. Would one of you readers expand on this concept in a letter to the editor?] Yamaguchi continued with a plea for more theoretical work, for measurement of gamma's, and efforts to define the mechanism and the nuclear processes.

Tsong P. Pergn: Dr. Pergn stressed the need for further study on materials and the hydrogen behavior. Also a further understanding of the optimum electrolyte is needed. What are the best types of "poisons" [promoters] such as thiourea? What is the effect of these additives on the overpotential? They appear to increase the fugacity of H and D by 5 to 10%. A better understanding of hydrogen diffusion is needed. The fugacity is a function of Temperature, molarity, etc. and what else? The diffusion rates in nickel is several orders of magnitude lower than with Pd. The surface is critical. We need to know how the H or protons [also D and deuterons] are trapped in or on the surface of an active cathode.

Takahashi: There is a need to study both the **direct** and the **indirect** relationships between the excess heat and the nuclear reactions. The analysis of the nuclear "ash" can lead to better understanding of this new science. The ability to produce tritium is steadily increasing. We need further work on the measurements of gamma-rays and X-rays [and their spectral densities.] Modeling and Theoretical work needs to have further studies.

Prof. Steven Jones: We found early that muon-catalyzed fusion was strongly related to temperature. The fusion yield was much greater than the expected 150 fusions per muon. However, it took eight years for "science" to accept this fact. In 1986 the first BYU experiments [with electrolysis] were conducted. In 1993 it will again be **eight years**. Prof. Jones stressed that we should continue to look for a trigger, "low-level, I mean." He also mentioned the phenomena of sono-

luminescence and its possible relationship to cold fusion. In closing, Jones stressed, "Let's keep working together."

Dr. Bressani: We should have improved measurements of neutrons and their energy spectrum. This type of project may have a high cost but it is needed to improve our understanding of the observed phenomena. We need to recuperate from the older type of experiments and plan and test new experimental systems. **It is essential that we have strong collaboration with solid-state scientists and the scientists skilled in chemistry.**

Dr. Peter Hagelstein: "Theorists are more comfortable in postdicting that in predicting because it is safer." The current problems are we need more experimental information (and replicability) in creating heat, in achieving proper D/Pd ratios in LiOD systems. We need to know more about the equivalent H/Ni ratios in the light-water potassium carbonate systems. Theorists need more information on tritium, neutrons, fast ions, and gamma rays and with as much spectral information as possible. For 60 years physicists have bet against some of the phenomena that we are faced with. We need to explain how the Coulomb barrier is being overcome: we need kinetic energy; screening, or neutral particles. There are differing experimental results. We, the theorists, need more data. How does the energy get out? Are there fast ions? What are the gamma energies? Are there transition energies? Are you finding isotopic shifts? How real is the transmutation of alkali elements? Is there any radioactivity in a Pd rod after the standard P-F treatment? Tell us about your experimental findings. [It may be important to subject a Nickel cathode to self-radiography after obtaining runs with excess heat.]

Discussion/Questions from Attendees:
Dr. Nate Hoffman: There are four aritfacts that need to be brought to everyone's attention: 1. **Major:** Helium difuses through glass. It takes time for helium to equilibrate with the glass. 2. **Minor:** Cosmic rays will disintegrate deuterium to given neutrons. 3. Radon decay products, such as decaying to ^{210}Pf can produce 8 meV particles. 4. Many fission products will be coming onto the market because there is considerable activity in processing or reprocessing nuclear fuels and these products will be radioactive.

Vigier: We must **know** if excess heat is obtained with both light- and heavy-water electrolysis. There are new effects with condensed matter and we will have to understand them.

Dr. Talbot Chubb: It is important to confirm [and replicate with high percentage] excess heat [in both light- and heavy-water cells.]

Dr. Robert T. Bush: Excess heat apparently is a byproduct of the transmutation of elements. We will see overwhelming evidence of this type of transmutation within a year. The effect is not predominantly due to deuterium contamination.

Dr. Talbot Chubb: There is a lack of internal review. Credibility is a serious problem. Using light-water electrolysis, hydrogen does not go into the Ni lattice.

Unknown: The carbonates in a light-water cell can be reduced at the electrodes. Therefore, be careful with calorimetry. The nickel cathode work with light water has only been under examination [in Japan] for two months. [Bush and Eagleton have been working on light water cells for over a year.]

Concluding Remarks to end the Third Annual Cold Fusion Conference by Dr. Hideo Ikegami:
Dr. Ikegami was impressed with many results of this meeting. He mentioned the videos shown by Pons and Fleischmann, the results of the experimental work by Dr. McKubre's group et al. The search for possible mechanisms for cold fusion is being furthered by the work of Yamaguchi and Aoka in Japan. He further stated that cold fusion is most important for our future generations. To achieve our goal will require excellent international cooperation. Cold fusion is not a subject to be studied by just one nation. It will be for the greatest good of mankind to be developed by many nations and the results shared around the world.

[This was a refreshing and intelligent statement to end the meetings. It is unfortunate that the Department of Energy in the United States could not have been provided with this same level of mature judgement. Ed.]

F. SHORT ARTICLES FROM READERS

WHAT TO AVOID
by Dr. Dennis Cravens

Most of our readers will undoubtedly already know what conditions to avoid to get positive results from cold fusion experiments. However, many may just be starting out and may benefit from other's experiences. When an experiment fails we often fail to report it. Yet often we can learn as much from our mistakes as from our successes. So here are some of my mistakes for all to see. You can sit back and laugh at my mistakes or perhaps take note and avoid the same pitfalls. These suggestions are for a palladium, lithium, and deuterium (heavy water) system.

The Anode

Don't use active materials for your anode. Remember that the positive ions from the anode can flow to the surface of the cathode. Don't have the electrical point of connection to the anode under the electrolyte. If a solder connection to the anode contacts the electrolyte it can cause lead or silver to be deposited on your cathode. I now use silver solder connections to the anode and make sure that the connection is outside of my cell. Silver wire does not seem to be as detrimental as copper. Copper can totally destroy the system if it contacts the

electrolyte from the anode side. It turns the solution green and ruins an otherwise good cathode.

Platinum seems to be the best anode material. Palladium can also be used. Silver, nickel, and osmium work sometimes. (I don't doubt that gold would work but have never tried it.) As you load from a Pt anode, a black or gray covering will form on your cathode. This coloring will look uniform if you do every thing just right. If it is not uniform, then you may have to start over or wait a long time. It seems that a uniform loading of the cathode is required for good results. Don't use just a few turns of the anode wire and expect to get it to work (don't "short change" the anode.) [Some experiments have had success using platinum mesh for the anode.] The field set up at the cathode should be as uniform as possible.

I think the black or gray film on the cathode is a build up of Pt or Pd and possibly some other materials. The film will be spotted if the loading is uneven. Since cathode regions exposed to the greatest electric field strength plate fastest, there can be a spotty build up on the cathode. I believe the overall effect is to cause a build up of Pt and hence increase in resistance in those regions. The system ultimately reaches a point of nearly uniform loading as the Pt increases the resistance in "hot spots".

Although it is possible to reach this even loading point by just being patient, it is better and faster to start loading the cathode using a uniform anode to cathode separation. You can also speed up the process by "spiking" the cell with some Pd, Al, Si, B, Os, or Re salts (but no chlorine). I prefer to add such things in the 10's to 100's ppm amounts after some slow initial loading without these promoters.

Don't use a small diameter long wire as an anode. The long length causes a voltage drop from end to end. This voltage drop results in uneven loading. It is better to use a basket, foil or other configuration which presents a uniform potential to the cathode. I now use a spiral down-spiral back up with access to both ends. This arrangement gives less end-to-end resistance loss along the anode. (This is because all I can afford is small diameter wire.) A large diameter mesh (net) with small loops or a foil cylinder may be a better anode design. (I feel I should give Dr. Glen Schessow the credit for emphasizing the uniform separation and loading, and Dr. Edmund Storms for the mesh idea.)

You can avoid obvious contamination from the anode by running it for a short time in a separate system to "blow out" any reactive impurities in the Pt.

Loading Current

Loading at a current density of more than 60 to 150 milliamps/square centimeter leads to cracks and deformation of the Pd lattice structure. Small diameter wires can be loaded at higher rates than large rods. I got in a hurry once and tried to quickly load a cathode. I could not get any results and once you have distorted a cathode it is virtually impossible to recover it (short from recasting it). Remember that the Pd will swell (about 10%) as it is loaded. If it is loaded too quickly, the outside and inside of the Pd could swell unequally leading to deformation of the lattice. (I think of shattering glass from thermal shock producing unequal expansion.) The larger the rod, the more stress that can build up.

The correct thing to do is to LOAD SLOWLY. I prefer 30 to 60 milliamps/square centimeter until I am past 150 ampere-minutes per cc of Pd or at a ratio of around 0.8 (d/Pd). After it is loaded, you can then go to high current densities. There seems to be a threshold as to where the effect "kicks in". This is usually somewhere around 200 to 500 milliamps/sq.cm. It seems to depend on how good a piece of Pd you have. I think the threshold results from the need to overcome the leaks out of the cathode (via cracks, voids, deformation...) with the flux of D into the rod. In other words, the effect does not start until you can push more D into the rod than is leaking out from the defects. The better the metal the lower the required current density. I have never been able to get results from a cell that did not "kick in" before 700 millA/sq.cm. If you do not get excess heat results before 700 mA per sq cm, it probably means that the cathode has too many defects and you will likely see areas of large bubbles on your cathode.

The Cathode

Don't let the top of the cathode get above the electrolyte. Any hydrogen entering the cathode from below can migrate up the cathode and then escape to the atmosphere. If the top is uncovered, you will have difficulty at getting above the 0.67 D/Pd ratio. If the cathode is large, you need to "push" the hydrogen into it from all directions. Don't forget that the hydrogen is being pushed into the cathode from the anode to the cathode. The hydrogen can migrate and "pop out" somewhere else, where there is not a flux being pushed by the electric field. It is like a balloon which must be pushed equally from all directions before you can get a real pressure increase. One experimenter (Dennis Letts) allowed a Teflon sheet to come between the anode and part of the cathode. This caused unequal swelling, spotted black areas from unequal Pt build up, and warping of the cathode. The moral is: You must have uniform loading. Likewise, an electrode that was polished on one side and rough on the other was observed to excessively swell on the rough side and warp the cathode.

The Electrolyte

Light-water percentages above 10% seem to "turn off the effect". A percent or two of light water does seem to smooth the heat bursts (it looks like they are going through a low pass filter). Don't forget that heavy water is hygroscopic and can absorb light water from the atmosphere. Carbon dioxide can react with the hydroxide (LiOD cells) to form carbonates in open cells and also from closed cells with carbon based recombiners. This is easy to monitor by checking the pH of the electrolyte.

Equilibrium conditions

Don't give up if you get no results from a static or equilibrium conditions. Change something. Try changing the current density, temperature, pressure, or the external magnetic field. I prefer to do my initial loading from an old unfiltered power supply. The ripples may be helpful. Likewise, a pulsed current on top of a base current density (of say 60 milliamps/sq.cm.) seems to give longer-lived effects.

A Final Note

If this information has been of help to you, then return the favor by sending a short note about your successes, suggestions, or even failures. *Fusion Facts* does serve the purpose of rapid dissemination of information about cold fusion. [Agreed! Editor.]

2ND Annual CONFERENCE PROCEEDINGS

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