FUSION facts

A Monthly Newsletter Providing Factual Reports On Cold Fusion Developments

ISSN 1051-8738 • University of Utah Research Park •

ISSN 1051-8738

VOLUME 2 NUMBER 2 FUSION FACTS AUGUST 1990

CONTENTS FOR AUGUST 1990

* * * * * * * * *

A. TO NUCLEAR PHYSICISTS: COLD FUSION PROVEN!

Four new scientific experiments demonstrate that the deuterium-palladium system and the deuterium-lithium-palladium electrochemical cell produce nuclear reactions. Through either scientific knowledge, complete faith in the world of known physics, or perceived threat to their source of funds, many nuclear physicists (some renown) have denied the possibility of cold fusion in a metal lattice. Dr. Morrison (CERN) has termed cold fusion as a pathological science. The officials of the American Physical Society rejoice in announcing, "the last nail in the coffin of cold fusion", and *Nature* suggests that the topic should be treated with derision.

However, the more responsible nuclear physicists have listed some perceived scientific evidence that must be demonstrated. Some of these suggested experiments or production of evidence of nuclear events are the following:

1. If deuterium atoms are fusing then there will be neutrons or tritium produced. Show us the evidence of nuclear reactions.

2. If the nuclear reactions involve the fusion of deuterium, then the branching ratio is well known to be about equal. Show us the count of neutrons and tritium.

3. If exothermic nuclear reactions are the source of the excess heat, show us the neutrons and/or the tritium together with the excess heat.

4. If cold fusion is a scientific reality, then show us the formula for replicating the experiments, such that similar results are achieved each time.

BACKGROUND

After Professor Steven Jones at BYU and Rafelski discovered evidence of nuclear reactions in selected metals and published their results [1] and after Professors Pons (U/U) and Fleischmann (The University, Southampton, England) had submitted their preliminary paper [2] the world became aware of the possible commercialization of solid-state fusion.

After several years of unannounced research, Pons and Fleischmann submitted their findings to the peer-reviewed *Journal of Electroanalytical Chemistry.* The ensuing dramatic interest in that paper resulted in the mailing and faxing of review copies around the world. The resulting flurry of inquiries led to the March 23, 1989 press conference where the world was told about the claims of nuclear fusion at near room temperatures.

The now-famous paper, "Electrochemically Induced Nuclear Fusion of Deuterium." [2] was submitted and

received for peer-review March 13, 1989 prior to the March 23rd press conference. In addition to being charged with unscientific handling of the news announcements (for which they were not responsible), Pons and Fleischmann have borne the unscientific ridicules of some fellow scientists, especially from the nuclear physicists (and others) who are strongly affiliated with the $500 million annual funding of hot fusion (through the Department of Energy).

THE NEW DISCOVERIES

In addition to the more than 60 scientists world-wide who have duplicated one or all of the Pons-Fleischmann discoveries [3], four new experiments have dramatically demonstrated the scientific evidence of nuclear reactions in a palladium environment. These four discoveries or experiments were made by Yamaguchi and Nishioka [4] at the NTT Basic Research Labs in Tokyo, Japan (equivalent to the U.S. Bell Laboratories); C.S. Yang and others [5] at the National Taing Hua University in Taiwan; B.Y. Liaw, P. Tao, P. Turner, and Bruce Liebert [6] at the University of Hawaii; and Thomas Claytor et al. [7] at Los Alamos National Laboratory.

To understand the scientific controversy that cold fusion has caused during the past sixteen months it is important to recall that the previous known fusion of deuterium (a heavy form of hydrogen) occurs only at very high temperatures and/or pressures (such as found in the sun). Physicists know for a surety that such fusion events produce either neutrons or tritium and associated energetic radiation. Physicists also know that the tritium branch and the neutron branch of the D + D nuclear reaction always occur in almost equal numbers at these high temperatures and pressures. Therefore, based on the sure knowledge of fusion of deuterium at high temperatures and pressures nuclear physicists know that such fusion **must be** measurable by monitoring neutrons or by measuring the tritium production or both.

The problem: in cold fusion the amount of heat generated has not been explained by the energy released with the production of the relatively small amount of tritium and/or neutrons measured. Even worse, many experimenters where unable to measure any significant amounts of neutrons, tritium, nor excess heat (of course not all experimenters performed the complicated electrochemical experiment correctly). In several cases experimenters did not measure significant amounts of neutrons nor tritium but they did get anomalous amounts of excess heat - which they did not consider to be **significant** and therefore reported negative results.

The results: Some scientists, unable to explain the laboratory findings of Pons and Fleischmann, (or the successful replication by many other scientists), and unable to replicate those findings in their own laboratories, have convinced themselves that cold fusion experiments were mistakes, errors, or delusions. The big challenge to the cold fusion experimenters has been made (as listed above in the four suggested experiments): "Show us the nuclear by-products of nuclear reactions (neutrons or tritium) and/or show us that you have both heat and nuclear by-products at the same time!" The challenge has been accepted and met with dramatic results as we are pleased to report below.

NEUTRONS AND HEAT - JAPAN

Drs. Yamaguchi and Nishioka [4] of the NTT Basic Research Laboratories, Musashino-shi, Tokyo 180, have made a remarkable experimental achievement by creating bursts of over one million neutrons per second from deuterated palladium. In the same experiment considerable heat is produced.

A gigantic burst of 1 to 2 million neutrons per second has been detected from palladium plates specially treated and loaded with deuterium in a vacuum chamber. The palladium plate is first plated on one side with gold and on the other side with a thin layer of manganese and oxygen. The diffusion rate for deuterium through the manganese-oxygen layer is smaller than the diffusion rate in the palladium. After plating, the palladium structure is allowed to dissolve deuterium gas that is injected into the vacuum chamber. After a suitable soaking time, the deuterium gas is pumped out and the deuterium gas within the palladium lattice begins to diffuse from the palladium. The deuterium gas within the Pd lattice cannot diffuse through the gold layer and the deuterium gas diffuses slower through the manganese-oxygen layer. The result is that the deuterium gas collects in the thin region between the palladium and the manganese-oxygen layer.

The experimental findings are:
1. An explosive release of deuterium;
2. An enormous burst of neutrons of about one million per second;
3. A rise in temperature of the palladium with its coatings and of the stainless steel supporting structure;
4. Bending of the Pd plate (like a bimetal); and
5. Physical changes to the color of the gold indicative of its rising to a temperature near the alloying point of gold and Pd.

This experiment is important because the release of such an enormous number of neutrons can only be the result of some type of nuclear reaction (probably involving the deuterium gas and the palladium). This scientific experiment, as fast as it is duplicated by other scientists, is expected to be a complete vindication of Professor

Steven Jones, measurements of neutrons in a cold fusion process [8]. Experimenters are encouraged to communicate with the authors because their paper suggests that it is not a simple experiment to replicate.

TRITIUM AND EXCESS HEAT PRODUCED -- TAIWAN

Dr. C.S. Yang and his associates [5] have replicated the Pons-Fleischmann electrochemical cell experiments using six different cells. They not only measured excess heat varying from about twenty percent to over one hundred percent, but they also measured the production of tritium on a daily basis with those same cells. In addition, this careful series of experiments worked similarly with all six of their experimental cells.

The impact is twofold: These scientist from Taiwan have shown that the Pons-Fleischmann work can be replicated and that there is a definite production of tritium. Because tritium can only be produced by a nuclear reaction, scientists (who accept this work) know that these experimental results are not chemical but nuclear.

Many teams of scientists have replicated the excess heat using the Pons-Fleischmann electrochemical approach. This work by Yang et al. is important because it is only the second report on the simultaneous measurement of tritium and heat in the Pons-Fleischmann electrochemical cell. The first report came from Bockris [9] at Texas A & M.

NUCLEAR REACTIONS IN MOLTEN SALTS - HAWAII

The two inventors of the use of molten salts to support cold fusion are Dr. Bor Yann Liaw and Professor Bruce E. Liebert, both of the University of Hawaii. Their work was reported on July 23, 1990 at the Cold Fusion Symposium, World Hydrogen Energy Conference #8, July 23-24, 1990, Honolulu, Hawaii [6].

This new approach for investigating nuclear reactions in a lithium-deuterium-palladium environment uses an eutectic mixture (to give lowest melting point) of KCl and LiCl. LiD is then dissolved in the molten solvent. The palladium anode is immersed in the hot melt (about 350 to 400 deg C). The aluminum container for the melt is used as the anode. The input voltages are kept below the level at which chlorine gas would be evolved from the salts. The experiments are currently being performed in a glove box using an argon atmosphere.

The experimenters precharged the palladium at 40 mA/sq cm for four weeks. The current was then increased to 600 mA/sq cm. At this current level the input power was about 2 watts. The output power ranged from 15 to 25 watts. The recorded temperature trace over time shows a rapid variation of output temperature within the range of about 15 to 25 watts of output power. The authors reported that it takes about 20 hours of "loading time" for this cell to go from the endothermic to the exothermic phase (the process of loading the anode is quite similar to the cathode loading in the standard Pons-Fleischmann electro-chemical cell). This experiment verifies predictions made by Pons and Fleischmann that more vigorous nuclear reactions should be expected at higher temperatures.

These scientists from the University of Hawaii plan to continue their work and determine if there are measurable amounts of neutrons emitted. The geiger counter used did not indicate any significant flux of neutrons. The use of more sophisticated neutron-measuring equipment is expected to be available soon. As this work is replicated by other laboratories, it may represent a significant breakthrough in the search for excess heat at higher temperatures.

REPLICATED TRITIUM PRODUCTION AT LOS ALAMOS

Dr. Claytor et al. [7] has achieved repeatable and dramatic results in the production of tritium (and some neutrons) in a deuterium gas-loaded series of experiments. The important fact is that the technique used by Claytor et al. is repeatable and the work is covered by theory in Dr. Yeong Kim's latest paper. See a review of Kim's paper in the report from the Hawaiian Hydrogen Energy Conference and a detailed report on Claytor's work as the first item under Other News From U.S. in this issue.

IMPLICATIONS AND NEED FOR REPLICATION

There is no question that these four experiments need to be replicated by other scientists in other laboratories. Only one of the four, Yamaguchi [4] has been published in a peer-reviewed journal. One comes from a U.S. National Energy Laboratory [7] together with personal communication that the experiment has been replicated three times with similar results. The work by Yang [5] was replicated in six cells; however, the seventh cell had not produced tritium (personal communication with author July 24, 1990). Reports of inconsistent results have been the rule, not the exception, in these types of electrochemical experiments (as in the early days of solid-state semiconductors).

The most dramatic report is Liaw et al. [6] because of the unusual high amount of excess heat reported. There will

be questions about the adequacy of the calorimetry work and also questions about the "ashes" of any suspected nuclear reactions. Early replication of this experiment by other laboratories is strongly urged. It is suggested that a closed cell be used so that the argon atmosphere need only be provided for the interior of the cell. It is suggested that the working cell be enclosed with a heat exchanger (such as a coil of stainless steel tubing) and then covered with insulation. This approach would alleviate the need for an expensive glove box and argon atmosphere equipment. Obviously, such a cell would have to be heated internally with a suitable electrical heater until the cell was producing its own energy.

If all four of these relatively simple experiments can be replicated by one or more laboratories, then the above lists of challenges by the nuclear physicists could be answered as follows:

1. If deuterium atoms are fusing, then there will be neutrons or tritium produced.
Neutrons of the order of one million per second are shown by the Yamaguchi [4] approach. Tritium production is shown by the Claytor [7] and the Yang [5] experiments and were replicated by the authors.

2. If the nuclear reactions involve the fusion of deuterium, then the branching ratio is well known to be about equal.
In this case it will be established that the branching ratio is not the same in the high-energy environment of hot fusion and low-energy environment of the palladium lattice systems. This finding of Claytor [7] is consistent with many other reports where the branching ratio is measured to be of the order of 10^7 to 10^9 more tritium than neutrons.

3. If exothermic nuclear reactions are the source of the excess heat, show us the neutrons and/or the tritium together with the excess heat.
Here again is the presentation of some new findings that will have an impact on the question as to the type of nuclear events that are responsible for excess heat. In no cases have the successful experiments demonstrated that all of the excess heat can be accounted for by the energy associated with the production of tritium or neutrons. This is strong evidence for the normal progression of science where experimental findings precedes theory. There are some who suggest that the excess heat may be due to a lithium-deuterium nuclear reaction.

4. If cold fusion is a scientific reality, then show us the formula for replicating the experiments such that similar results are achieved each time.
Internally, replication has been achieved by Claytor [7] and Yang [5]. Further replication by other scientists in other laboratories needs to be demonstrated for the intense production of neutrons as done by Yamaguchi and Nishioka [4] and for the remarkable production of excess heat as reported by Liaw et al. [6]. As soon as these replications are independently verified, the reality of cold fusion will have been established.

FINAL NOTE

In the face of severe criticism, disbelief, and (at times) ridicule, many great and dedicated scientists and students of science have continued their exploration of cold fusion. We congratulate four groups of experimenters (cited here) for their excellent experimental design and operation and, of course, for their exciting results. These are the type of scientists and technicians that will help resolve some of the world's energy and environmental problems. We honor you. [Hal Fox, ED.]

REFERENCES

[1] J. Rafelski & S.E. Jones, *Scientific American,* 267, pp 84-89, (July 1987).

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

[3] "Cold Fusion Successes, Achievements, and Primary Sources", *Fusion Facts,* Vol 1, No 12, June 1990, pp 5-12, 31 refs.

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

[5] C.S. Yang, C.Y. Liang, T.P. Perng, L.J. Yuan, C.M. Wan, and C.C. Wan (Materials Science Center, National Tsing Hua University, Hsinchu, Taiwan, 30043, R.O.C.), "Observations of Excess Heat and Tritium on Electrolysis of D_2O", Presented at the Cold Fusion Symposium, World Hydrogen Energy Conference #8, July 23-24, 1990, Honolulu, Hawaii.

[6] Bor Yann Liaw, Peng-long Tao, Patrick Turner, Bruce E. Liebert (Univ of Hawaii), "Elevated Temperature Excess Heat Production Using Molten Salt Electrochemical Techniques", Presented at the Cold Fusion Symposium, World Hydrogen Energy Conference #8, July 23-24, 1990, Honolulu, Hawaii.

[7] T.N Claytor, P.A. Seeger, R.O. Rohwer, D.G. Tuggle, and W.R. Doty (Los Alamos National Laboratory), *Technical Information Release LA-UR-89-3946,* an unclassified report presented at the NSF/EPRI Workshop

on Anomalous Effects in Deuterated Materials, October 18, 1989, Washington, D.C. [accepted for publication in *Fusion Technology*].

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

[9] R.C. Kainthla, O. Veleve, N.J.C. Packham, L. Kaba, and J. O'M Bockris (Texas A&M), *Proceedings of the EPRI/NSF Conference on Cold Fusion Phenomena,* Washington, D.C. October 18, 1989, Washington, D.C. [The authors report on the production of tritium correlated with excess heat].

* * * * * * * * *

B. STATUS OF COLD FUSION IN JAPAN AND INDIA

(Courtesy of Dr. Fritz G. Will, Director, National Cold Fusion Institute) Dr. Will recently returned from a trip to Japan and India. The following article is his summary report:

IMPRESSIONS ON THE STATUS OF COLD FUSION IN JAPAN AND INDIA

By Fritz G. Will, July 19, 1990

Large numbers of researchers are continuing cold fusion work in both Japan and India. Significant new results, achieved in the past few months, leave no doubt that fusion of deuterium occurs in deuterium-loaded metals at ordinary temperatures, unassociated with cosmic ray events. In a research environment markedly different from that in the United States, groups in both countries are pursuing cold fusion phenomena in excellent cooperation between nuclear physicists, electrochemists, and materials scientists.

Emission of neutrons with 2.45 MeV energy from deuterium-loaded cathodes and simultaneous tritium generation have now been shown at Osaka University to be correlated to the electrolysis conditions, thereby proving electrochemically-stimulated cold fusion of deuterium. Furthermore, neutron bursts and significant tritium generation have been demonstrated on D_2 gas-loaded tritium chips at the Bhabha Atomic Research Center in India. Lastly, significant temperature rises have been observed on deuterium-loaded palladium, both in D_2 gas and in LiOD electrolytes and, in both cases, accompanied by mass 3 or tritium generation.

In Japan, between 40 and 50 different groups, involving approximately 200 scientists, work on various aspects of cold fusion. The efforts of twenty of these groups are coordinated by Professor Ikegami, a nuclear physicist and Director of the National Institute for Fusion Science at the University of Nagoya. The research philosophy regarding cold fusion in Japan was stated by Professor Ikegami some time ago this way: **"We in Japan are interested in proving cold fusion, whereas our colleagues in the United States seem more interested in disproving it."**

In India, cold fusion research is carried out in three centers: the Bhabha Atomic Research Center, the Tata Institute for Basic Research (both located in Bombay) and the Indira Ghandi Atomic Research Center in Madras. A total of 15 groups, with approximately 70 researchers, are involved. Dr. Iyengar, formerly director of the Bhabha center and now Chairman of the Atomic Energy Commission, sums up his philosophy with regard to cold fusion research this way: "We have no sentiments for nor against hot fusion or cold fusion. New nuclear phenomena are doubtless occurring in deuterium-loaded metals that we want to study and understand."

The most significant new developments are the following: Professor Takahashi, a neutron physics expert at the University of Osaka, has uniquely determined the energy spectrum of neutrons emitted during the deuterium loading of palladium electrodes in LiOD solutions, and thereby strikingly confirmed cold fusion. He found a sharp peak at 2.45 MeV, characteristic of d-d fusion and, surprisingly, a second broad peak at between 3 and 7 MeV. The maximum level of neutron emission was 15 neutrons per second and production of tritium up to three times background. Importantly, the neutron emission was in time registry with changes in the electrolysis conditions, thus ruling out cosmic ray events as the cause for the observed neutrons.

On the basis of quantum mechanical calculations, Professor Takahashi has assigned the higher energy maximum to the three-body reaction, d-d-d. Excess tritium generation has on one occasion been found to be associated with neutron generation in the ratio of about 10^5 tritium/neutrons. Similarly high ratios have been found by Indian and Italian groups in deuterium loading of titanium. Such high ratios are incompatible with conventional nuclear physics and demonstrate the occurrence of new nuclear processes in deuterium-loaded metals.

Dr. Srinivasan and his colleagues at the Bhabha Institute have determined tritium and neutron generation in a plasma focus experiment on deuterium-loaded titanium, giving a tritium/neutron ratio of 10^7. No emissions were found on copper, brass and aluminum electrodes which do not support the internal acceptance and storage of deuterium. In newest experiments performed by this

group, individual deuterium-loaded titanium chips have generated strong tritium emissions, corresponding to 2 x 10^{15} tritons from a 4 mg chip. The tritium chips also emitted strong neutron bursts, between 10 and 100 times background.

Various Japanese groups are now starting to focus on excess heat generation in deuterium-loaded palladium. Drs. Yamaguchi and Nishioka at NTT laboratories have found repeated temperature rises of 10 degrees C in deuterium-loaded Pd foils when passing a 5A current through the foil. One side of the foil was provided with an Au film, the other with an SiO_x film. The temperature rises were accompanied by a distinct mass 3 peak as observed in a mass spectrometer, indicating the possible formation of tritium. Prof. Ikegami and his group have observed temperature rises to 100 degrees C during electrolytic loading of D into Pd and Pd alloys under conditions where spontaneous recombination was eliminated.

A similar significant result was obtained by Drs. Saini and Ray in very carefully executed D loading of a Pd cathode. A 10-minute heat burst was observed, during which the cathode temperature rose by 25 degrees C and a heat generation rate of 40 W was calculated. Gas recombination was eliminated as a possible cause by verifying that the D-loading of the Pd had remained essentially constant. A 40 percent enhancement in the tritium content in the recombined off-gas was observed after the heat burst.

COLD FUSION RIDICULED IN U.S.

At the same time that significant progress is obtained elsewhere, the unproductive controversy on the reality of cold fusion continues in the United States. The controversy is fueled by a small number of vocal nuclear physicists, and a few others. Unethical and unprofessional methods are now being employed by these few in an almost desperate attempt to prevent scientists from pursuing the exploration of these new scientific phenomena. These are the results: Positive results on cold fusion have been suppressed at several universities; young professors have been warned that they would not receive tenure unless they would disassociate themselves from cold fusion; pressure has been applied on sponsors of cold fusion work to withhold or cut research grants for cold fusion; *SCIENCE* magazine, published by the American Association for the Advancement of Science, has hurt its reputation by allowing a science writer to publish slanderous, nonscientific gossip that should only have been published in a tabloid paper; the editor of *NATURE* has blocked publication of articles reporting evidence of cold fusion while accepting mediocre papers critical of cold fusion. [See page 21 for the latest denigrating remarks about cold fusion from *Nature*. Ed.]

The very same scientists, who so vocally defend their own academic freedom, have attempted to undermine the scientific freedom of their own colleagues working on cold fusion. The constant barrage of attacks on cold fusion and the continuing distortions and misrepresentations of scientific results is unacceptable. These actions by a small group of scientists have led to deceiving the government, the media, and the public at large about the true status of cold fusion. The result has been great harm to the progress of cold fusion work in the U.S. The time has come to examine the motivations of this group of scientists and to halt their attempts to hinder the progress of a new area of science.

COMMENTS

We look forward to a promised interview from Dr. Will in which we expect to learn more about his visits to Japanese and Indian scientists.

Since this report was received from Dr. Will, the U.S. has again entered a stage of energy crisis. The U.S. again finds itself at a great disadvantage by its dependency on foreign countries for its oil. Under such conditions of national security, it is a despicable and unpatriotic act to deliberately stifle the development of any new energy technology. It is even more contemptible when such acts are the deliberate attempt to ensure the traditional flow of research funds on hot fusion. Fusion Facts urges the support of our readers to have the Energy Committees of the Congress of the United States schedule and hold public hearings on cold fusion. *Fusion Facts* does not promote the idea that cold fusion research should be supported by taxpayer funds. The cost of entry into this technology is so low that even the smallest technology companies could proceed with development work **if they were allowed to know the true facts about cold fusion.** See the following letter. Ed.

* * * * * * * * * * *

C. LETTER TO CONGRESSIONAL ENERGY COMMITTEES

The following letter was mailed August 8, 1990 to the Senators and Congressmen as shown. Fusion Facts had tried for several months to correspond with Admiral Watkins (Secretary of Energy); Dr. Bromley (Science Advisor to the President); or Dr. Sununu (Chief of Staff) without satisfactory results. In the face of the distorted findings of the DoE Cold Fusion Panel, there is little hope of getting the true scientific facts about cold fusion to any decision makers in the Bush administration. If you agree that the reality of cold fusion should be made public, please ask your Senators and Congressmen to support the request made in the following letter. Fusion

Facts will send a free diskette with a tutorial on cold fusion to all those who write to their national senators or representatives and send us a copy. [Ed].

From: Hal Fox, Editor-in-Chief, Fusion Facts

To: The Honorable J. Bennett Johnston and
The Honorable James A. McClure
Senate Energy and Natural Resources Committee
The Honorable John D. Dingell and
The Honorable Norman F. Lent
House Energy and Commerce Committee

Honorable Sirs:

If we have a choice between risking the lives of the members of our Armed Forces in the Persian Gulf or developing our own energy resources, which choice would the government make? When U.S. scientists can now obtain as much as ten times the energy out of a cold fusion device as compared to the energy in, should we not change our national energy priorities to support this form of alternative energy?

The United States need not continue to be dependent on foreign oil for our energy uses. The original discovery of cold fusion (Fleischmann and Pons paper submitted to *Journal of Electroanalytical Chemistry* March 17, 1989) and its announcement has led to dramatic scientific breakthroughs. The enclosed Press Release cites the work that has been done in Taiwan, Japan, Hawaii, and Los Alamos National Laboratory that conclusively proves the scientific reality of cold fusion and demonstrates a strong potential for future commercialization.

The Department of Energy has been misled by its advisors about the developments in cold fusion. The end result has been the labeling of cold fusion with such phrases as "the last nail in the coffin of cold fusion"; "pathological science"; "a scientific fraud"; etc. The lack of proper scientific oversight by DoE in this dramatically advancing science has resulted in a lack of serious attention being given to this new scientific breakthrough. The media looks to the DoE for direction in new energy technologies and finds that DoE scientific advisors are willing to discredit cold fusion. Many (if not all) of these advisors are supported by DoE hot-fusion funds.

If the Congress of the United States depends on the DoE for important energy information, they will be misled in the area of cold fusion. **This issue is so important to America and its citizens that we strongly urge the Chairpersons of our Senate and House Energy committees to immediately schedule and hold public hearings on the scientific findings in cold fusion.**

In Japan over 40 groups involving about 200 scientists are working on cold fusion developments. The efforts of 20 of these groups are coordinated by Professor Ikegami (a nuclear physicist). His comments are, "We in Japan are interested in proving cold fusion, whereas our colleagues in the U. S. seem more interested in disproving it."

The enclosed copy of the June 1990 issue of *Fusion Facts* lists over sixty scientists who have been successful in replicating and publishing peer-reviewed scientific articles or presenting papers at scientific meetings on cold fusion. A selection of these scientists should be invited to meet with and present their findings to the Congressional energy committees.

It is the studied conclusion of Fusion Facts that the development of cold fusion should be funded primarily by corporations and not by public taxes. As contrasted to the development of nuclear power, the entry costs for cold fusion development are very small. For example, the breakthrough at the University of Hawaii was made with an expenditure of about $250,000. American industry would now be making great progress in developing cold fusion if the Department of Energy were supportive of this remarkable new American discovery. Because of the advice of grossly underinformed advisors, the DoE can be charged with misleading the American public. Our United States Senators and Congressmen, as representatives of all Americans, should not allow this miscarriage of government energy policy to continue. In this time of energy crisis, we must encourage corporate America to help solve our future energy problems. Corporate America can and will perform if they are not working under misdirection by DoE.

Sincerely,

Hal Fox, Editor-in-Chief
Fusion Facts

P.S. We would like to publish your reply to this letter in our next issue of *Fusion Facts*.

* * * * * * * * * *

D. HAWAIIAN WORLD HYDROGEN ENERGY CONF. #8

NOTE: COLD FUSION SYMPOSIUM PROCEEDINGS AVAILABLE Order from:

WHEC#8
Hawaii Natural Energy Institute
University of Hawaii
2540 Dole Street, Holmes Hall 246
Honolulu, HI 96822 USA

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

WHEC#8 COLD FUSION SESSIONS - SUMMARY

The conference was held in Hawaii in the Sheraton hotel on the beach at Waikiki, Honolulu, Hawaii. Two cold fusion sessions were held July 23-24, 1990. The following is a summary of the papers presented at the conference.

PLENARY SESSION - DR. JOHN O'M. BOCKRIS

Dr. Bockris stated that he had to rewrite the notes for his presentation due to the work being accomplished at the University of Hawaii. [See report on paper by Liaw et al. below.]

Noting that few experimenters had reported neutrons that were much in excess of background measurements, Bockris reported on some amazing news that was just reported in the *Wall Street Journal* where enormous bursts of neutrons (up to 3 million neutrons per minute) resulted from a Japanese cold fusion experiment. [See report on Yamaguchi's work, p. 1 of *Fusion Facts* July 1990 issue.]

Bockris noted that the many experiments that had been performed in attempts to replicate the Pons-Fleischmann work had a history of obtaining excess heat; but that it did take 30, 60, or 90 days before success was obtained. Problems that are not as yet understood caused many different results. Even after excess heat was obtained, it would often later stop for no apparent reason.

However, definite signs of nuclear reactions have been obtained. Regardless of the Taubes article in *Science*, tritium has been produced by these cold fusion reactions and replicated by more than 20 scientists. [See article about Taubes "Spiking Cold Fusion", page 16, *Fusion Facts*, July 1990; also report on tritium, page 12, *Fusion Facts*, June 1990.]

Bockris presented a series of overhead transparencies detailing the tritium results from various experimenters including his own work at Texas A&M. He noted that regardless of the difficulties of replicating the cold fusion experiments, at the present state of understanding, there was ample evidence of the production of tritium. Tritium cannot be produced by any known chemical means; therefore, the scientific evidence is that there are nuclear reactions occurring in a deuterated palladium system.

MORRISON'S PATHOLOGY

Dr. Douglas Morrison also presented his thesis that cold fusion could be pathological science. He ignored all of the tritium evidence and emphasized the negative reports. [Marlin fishermen may be 20% successful. By Morrison logic, those who catch marlin may be deluded by pathological fishing.] Because cold fusion could be deemed an intrusion into a hydrogen energy conference, it was not a great surprise that Morrison received vigorous applause. "Oh good! We don't have to worry about the competition of cold fusion." seemed to be the attitude of many at the plenary session of this hydrogen conference. During the question period, Dr. Nate Hoffman noted that, in general, the negative experiments are more poorly done. Dr. Hoffman has been examining many Pd samples for evidence of nuclear signatures and reports on the difficulty of proving cold fusion if the reaction by-products are ^{3}He, ^{4}He, or similar low-mass atoms. These atoms are immersed in a number of other similar mass atoms or molecules such as H_2, D_2, HD, T, HT, etc. Ed.

FIRST SESSION COLD FUSION PAPERS

Chaired by Steven Jones and John Bockris, July 23, 1990

The following are summaries presented July 23, 1990:

JONES ON GEOLOGIC FUSION

Steven E. Jones (BYU), "Recent Progress in Condensed Matter Fusion", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Prof. Jones reviewed the history of his work in piezo-nuclear fusion in isotopic hydrogen. [References on early publications are: J. Rafelski & S.E. Jones, *Scientific American*, 267, pp 84-89, (July 1987); and S. E. Jones, E. P. Palmer, J. B. Czirr, D. L. Decker, G. L. Jensen, J. M. Thorne, S. F. Taylor, and J. Rafelski, "Observation of cold nuclear fusion in condensed matter.", *Natur*e, 338, pp 737-740 (1989).]

The suggestion by Prof. E.P. Palmer concerning the possible geological fusion of isotopic hydrogen has been investigated. Jones showed a slide of the tritium measurements downwind from a Hawaiian volcanic eruption in which large amounts of tritium were measured. Jones also showed a slide of the latitudinal distribution of tritium along a line running from Antarctica to Hawaii to Los Angeles. Investigations are now being conducted under a DoE grant to study tritium in volcanic gases and trapped in volcanic submarine lava.

Jones reported on his continuing work with Menlove at Los Alamos in which Ti chips are subjected to D_2 gas and temperature cycled. Numerous bursts of neutrons are detected.

In summary, Jones stated that his continuing investigations are directed to the study of geological evidence (especially from volcanoes); the reduction in background neutron radiation to improve data reliability; the use of multiple neutron detectors; and the search for a trigger mechanism that may be responsible for the neutron bursts that have been observed.

GUR ON EXCESS POWER WITH FUSION

Turgut M. Gur, Martha Schrieber, George Lucier, Joseph Ferrante, Robert Huggins (Stanford U.), "Experimental Considerations Involved in the Generation of Excess Power as a Result of the Electrochemical Insertion of Hydrogen and Deuterium in Palladium", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Gur's paper dealt with the generation and measurement of excess power using the Isoperibolic Calorimeter. Gur's paper emphasized the design and use of the calorimeter including information about the time constant of the instrument and it potential use up to 600 deg C.

These experiments were performed using a specially designed isoperibolic calorimeter. The time constant of the calorimeter is about 13 to 15 minutes. In the electrochemical cell, the palladium "fat dime" cathode is supported within a "nest" of Pd wire. The cell is closed. About 40 hours are consumed for a typical careful calibration of the calorimeter and the data has been shown to be linear within a few tenths of a percent over the range of 30 to 60 deg C. The calorimeter can operate up to about 600 deg C. The basic structure is aluminum and Al_2O_3 for insulation.

For similar information (while awaiting the publication of the Proceedings), please see the following paper by Gur et al. which is now available. See notice near end of this issue about the availability of the proceedings of the Mar. 28-31, 1990 First Annual Conference on Cold Fusion.

T.M. Gur, M. Schreiber, G. Lucier, J.A. Ferrante, J. Chao and R.A. Huggins, (Stanford), "Experimental Considerations in Electrochemical Isoperibolic Calorimetry" *The First Annual Conference on Cold Fusion - Conference Proceedings*, March 28-31, 1990, University Park Hotel, Salt Lake City, Utah, Publ by NCFI, pp 82-90, 4 ref.

ABSTRACT

A novel concentric cylinder isoperibolic calorimeter was designed and fully characterized. Several different methods of introducing calibration power to the calorimeter were studied and the calibration constant was found to be independent of the method. Calibration constants could be determined with a precision to + or - 0.5%. Furthermore, they were independent of the input power level up to 22 W and with a cell temperature up to 60 deg C over appreciable periods of time. This new design possesses many advantages that makes it suitable for careful studies of the thermal behavior of electrochemical systems, such as the electrochemical insertion of deuterium into Pd cathodes.

EXPERIMENTAL RESULTS - SCHREIBER

Martha Schrieber, Turgut Gur, George Lucier, Joseph Ferrante, Robert Huggins (Stanford U.), "Recent Experimental Results on the Thermal Behavior of Electrochemical Cells in the Hydrogen-Palladium and Deuterium-Palladium Systems", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Dr. Schreiber reported on the results of extensive tests where similar experiments were done with the only change being light water or heavy water. No excess energy resulted from the light water experiments. Over 22 megaJoules per probe of Pd were produced in one cell using heavy water. The cell used a platinum anode and palladium cathode, with a 0.1M LiOD electrolyte. The experiments have conclusively shown that the excess energy is not chemical.

The cathode preparation includes arc melting of the palladium in an argon atmosphere 5 to 10 times. The Pd is then hammered into the shape of a "fat dime". A typical amount of Pd used is about 2.4 grams. The amount of excess heat obtained is about 6 to 7%. In one cell a thirty-minute burst of heat was recorded with a maximum of about 56% excess heat.

Dr. Schreiber discussed the possibility of a lithium nuclear reaction of the type $D + {}^6Li \text{ ----> } {}^7Li + H + 5$ MeV or $D + {}^6Li \text{ ----> } 2\,{}^4He + 22.4$ MeV, and noted that it would be very difficult to measure the end products of either of these two reactions.

For similar information (while awaiting the publication of the Proceedings), please see the following paper by Schreiber et al. which is now available. See notice near end of this issue about the availability of the proceedings of the March 28-31, 1990 First Annual Conference on Cold Fusion:

Martha Schreiber, T.M. Gur, G. Lucier, J.A. Ferrente, J. Chao and R.A. Huggins, (Stanford), "Recent Measurements of Excess Energy Production in Electrochemical Cells Containing Heavy Water and Palladium", *The First Annual Conference on Cold Fusion - Conference Proceedings*, March 28-31, 1990, University Park Hotel, Salt Lake City, Utah, Publ by NCFI, pp 44-56, 7 refs.

ABSTRACT

This paper reports calorimetric experiments related to the energy breakeven issue during heavy water electrolysis using a Pd cathode in thermodynamically closed cells. A comparison with light water electrolysis under the same conditions is also given. Excess power has been observed in a number of cases in which the overall energy balance becomes positive after a short period, leading to the generation of significant amounts of excess energy. In one case, excess power was maintained over a period of ten days, and produced over 22 MJ of excess energy per mole of palladium.

KREYSA - EXPERIMENTAL STUDIES

Gerhard Kreysa, G. Marx, W. Plieth, M. Schutze, B. Zeitnitz, W. Heeringa, H. Klages (FRG), "Experimental Study of Possible Cold Fusion in Titanium and Palladium Electrodes", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Kreysa reports on finding 450 counts of neutrons at energy levels of about 2.22 MeV and suggests that these may have been a Bismuth event. Experiments were deemed to be negative in finding evidence for cold fusion.

LIAW - NUCLEAR REACTIONS IN MOLTEN SALTS

Bor Yann Liaw, Peng-long Tao, Patrick Turner, Bruce E. Liebert, "Elevated Temperature Excess Heat Production Using Molten Salt Electrochemical Techniques", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

This new approach for investigating nuclear reactions in a lithium-deuterium-palladium environment uses an eutectic of KCl and LiCl. LiD is then dissolved in the molten solvent to produce a saturated solution. The palladium anode is immersed in the hot melt (about 350 to 400 deg C). An aluminum container is used as the anode. The input voltages are kept below the level at which the chlorine gas would be evolved from the melt. The experiment is carried out in a glove box using an argon atmosphere.

The experimenters precharged the palladium at 40 mA/sq cm for four weeks. The current was then increased to 600 mA/sq cm. At this current level the input power was about 2 watts. The output power ranged from 15 to 25 watts. The measured trace of temperature (as projected on the screen during the presentation) over time varies quite rapidly up and down within the range of about 15 to 25 watts. New data shows that it takes about 20 hours for a cell to go from the endothermic to the exothermic phase (function of loading the anode is quite similar to the Pons-Fleischmann electro-chemical cell). These experiments verify predictions made by Pons and Fleischmann that improved results (in terms of excess heat) should be expected at higher temperatures.

The authors note that the use of the molten salt electrochemistry has the following benefits:

1. Operates at elevated temperatures.
2. Produces a strong reducing environment.
3. Provides high grade heat output.
4. Enhances the thermodynamic efficiency.
5. Raises the reaction rates.
6. Reduces the electrochemical preparatory work.
7. Shortens the induction time (to load the Pd cathode).
8. Provides a high total efficiency.

The working cell is supported in a calorimeter bath which is heated by a constant power supply to provide 50 Watts. Considerable effort is made to produce accurate calibration, both before and after each experiment. The example of a working cell showed that the temperature rise within the cell (as compared to a calibration cell) was in the range of 75 to 80 deg C.

The reported excess heat ranged from about 500% to 1200% over about a 90 hour period. These remarkable results are the highest yet reported for any continuous operation in a cold fusion experiment.

The report also provided information that the use of titanium as an anode also produced excess heat, but not at the level produced when the anode was palladium. These scientists expect to continue their work and determine if there are measurable amounts of neutrons emitted. The geiger counter used did not indicate any significant flux of neutrons.

Fusion Facts (and many interested scientists) will welcome any reports on the replication of this astonishing expansion of the cold fusion technology. Ed.

WIESMANN - BROOKHAVEN NEGATIVE?

K.A. Ritley, K.G. Lynn, P. Dull, M.H. Weber, H. Wiesmann (Brookhaven), "A Search for Cold Fusion Signatures in Cathodically Charged Palladium", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Dr. Wiesmann presented his negative findings in searching for fusion signatures. When questioned about Dr. James McBreem's (Brookhaven scientist with excellent electrochemistry experience) positive results (tritium and excess heat), Dr. Wiesmann stated that he had talked with Dr. McBreem and that he is not sure that McBreem would want to be quoted. Dr. Wiesmann admits that he is measuring "excess heat" but prefers to explain it by other than fusion events. He admitted at the conference that his approach may not be a good one to copy.

NOTE: *Fusion Facts* has noted in a previous issue that our policy is not to report all negative findings. We have great respect for the work being done by scientists in replicating and explaining this new technology. Where we find reports of negative results we try to provide information that will change their experimental work to positive results. We do not want to add any embarrassment to those scientists who honestly failed to replicate a very difficult experiment. We are pleased to note that some who had early lack of success are now numbered among those who are presenting papers depicting their positive findings. We hope that the information that *Fusion Facts* has obtained and shared has been helpful. Ed.

BABU - EXPERIMENTAL

K.S. Chandra Babu, N.P. Lalla, R.N. Pandey, R.S. Tiwari, and O.N. Srivastava (Baumas Hindu University, Varanasi, India), "On the Formation of Palladium Deuteride and its Relationship to Suspected Cold Fusion", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Dr. Babu reported that from a theoretical viewpoint a D + P nuclear reaction should be preferred over a D + D nuclear reaction. The charts presented showed gamma ray production by an experimental cell with intensity plotted versus wave length. The graphic results were interpreted to show that D + P --> ^{3}He + energy is the suspected reaction that produced the observed gamma rays.

Dr. Babu reported that they observed temperature increases of 80 deg C, but that he had not computed the amount of excess heat. Babu emphasized that the PdD + H experiments should be different from PdD + D experiments. The later is theoretically more capable of providing fusion reactions.

HUANG - KILLING FUSION BY WATER

Ning Huang, Quing-Hua Gao, Bor Yann Liaw, Arthur Seki, Bruce Liebert (U. Hawaii), "Effect of Light-Water Additions on Excess Heat Generation in Palladium-Deuterium System", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Huang reported on experiments in which Pd, melted and prepared at Stanford, was used in electrochemical experiments to determine the effect of adding light water to a working electrochemical cell. After 100 days of operation the total quantity of excess heat was greater than zero (the endothermic reactions had been surpassed by later exothermic processes). Light water was added to the 0.1M LiOD and heavy water electrolyte.

The results were that the quenching of the excess heat did not occur immediately but that it required 20 to 40 hours for the quenching to be effective. [Other experiments have found similar results and some have found the excess heat to diminish immediately. These contrary results seem to indicate a combination of both surface and bulk reactions. Comments anyone? Ed.]

The author also reported that they had used controlled electrolysis to purify a previously-used Pd cathode. H is preferred to be electrolyzed and H prefers to remain in the cathode. An interesting approach is to have the Pd electrode remain partly in and partly out of the heavy water electrolyte. It appears that the Pd cathode would then be loaded with D below the electrolyte surface and be purging other gases out above the surface.

NOTE: We hope that this interesting experiment will be further reported in the forthcoming proceedings. Limited time constraints at the meeting prevented further discussion. Ed.

SECOND SESSION COLD FUSION PAPERS

Chaired by Robert Huggins, July 24, 1990

HUGGINS - MATERIALS SCIENTIST TUTORIAL

Robert A. Huggins (Stanford), Werner Wepner (FRG), "Fundamental Considerations Relating to the Electrochemical Insertion of Hydrogen and Palladium into Mixed Conductors", *Proceedings of the Cold Fusion Symposium, World Hydrogen*

Energy Conference #8, Honolulu, Hawaii, July 23-24, 1990, in press.

This report presented by Prof. Huggins is one of the more important papers that has been given in cold fusion conferences. The presentation provided insights into the difficulties of dealing with the multi-disciplinary problems of cold fusion (physics, chemistry, electrochemistry, and more important the aspects of materials science in the electrochemical environment). It is the opinion of this reviewer that if the honest scientists at Cal Tech, MIT, Brookhaven, Harwell, and others who have found negative results from their cold fusion experiments, had first studied the materials presented in this session by Prof. Huggins, they would have had initial successes at replicating the Pons-Fleischmann experiments. Prof. Huggins, you may remember, was one of the first to find anomalous heat in a lithium-deuterium-palladium electrochemical environment. It is also of considerable interest that the co-inventors of the molten salt fusion invention (Drs. Bruce Liebert and Bor Yann Liaw) were both students at Stanford with close ties to the Materials Science Department.

Professor Huggins addresses the following issues (and others) that make the cold fusion replication a difficult problem:

1. Electrochemical insertion causes high stresses.
2. Problems of non-uniform distribution.
3. Segmentation due to extended lattice defects.
4. Generation and movement of large dislocations and concentrations.
5. Enhanced solute transport.
6. Use of poisons and promoters. (Examples are P, As, Sb, Bi, S, Se, Te, I, CN (in small concentrations). Also inhibitors or blockers such as O and oxides, SO_2, NH_3 and carbon.
7. The effect of atomic H at metallic surfaces.

With each of these subjects (and others) Huggins provides us with references to the pertinent literature. It will be worth more than the cost of the proceedings to have the information contained in this important paper by Huggins and Wepner. A copy of the Huggins and Wepner paper was not as yet received by press time. This information deserves more attention, especially the information on poisons and promoters. As soon as we can obtain a copy of this paper (and appropriate permission), we will provide a more adequate review. Ed.

KIM - COLD FUSION THEORY

Yeong E. Kim (Purdue), "Nuclear Physics Interpretation of Cold Fusion and Optimal Designs for Gas/Solid State Fusion Device", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8,* Honolulu, Hawaii, July 23-24, 1990, 10 pages, 40 refs, in press. [Paper is available from the author as PNTG-90-12, July 1990, Dept of Physics, Purdue U., W. Lafayette, Indiana 47907.] A second paper, "The Effect of Electron Screening on Cold Fusion", was not available, but the two papers were presented in a combined presentation by Dr. Kim.

ABSTRACT

Based on a surface fusion mechanism consistent with conventional nuclear physics, plausible explanations are described for both the positive and negative results of heavy water electrolysis experiments. A set of experimental conditions for optimizing cold fusion rates are described in the context of the surface fusion mechanism. Several optimal designs are described for gas/solid-state fusion devices which may achieve the reproducibility and reliability required for practical large-scale applications.

COMMENTS

Dr. Kim states in his paper, "In this paper, the surface fusion mechanism is described for the purpose of providing a basic theoretical interpretation of the gas/solid-state fusion process and is used in designing gas/solid-state fusion devices which optimize the total fusion rates and may achieve the reproducibility and reliability required for practical large-scale applications." Kim references the work by Claytor, et al. at Los Alamos and notes that their results for tritium production are highly reproducible. [See also the review of Claytor's paper under Other News From U.S. Ed.]

Dr. Kim gives the following suggestions (to maximize the fusion rate) that follow from the equations developed in his theoretical work:

1. The deuterium density should be optimized and maintained at a maximal value on and inside the surface of the deuterated metal.
2. The incident D^+ flux should be adjusted to a maximal steady pulsed current.
3. The total fusion rate can be increased by raising the incident D^+ kinetic energy.

Dr. Kim showed us a chart of tritium versus neutron branching ratios as determined by various experiments ranging from the low energy experiments in cold fusion to the high energy experiments in hot fusion. The chart shows that there is a definite change in the branching ratio at the low energy end to favor tritium over neutron production. Claytor's work (which is reproducible) shows branching ratios which highy favor tritium production. See the report on Claytor's work in the lead article for this issue and a review of his paper under the section Other News From U. S.

HORA - PLASMA-SURFACE MODEL

George H. Miley, M. Ragheb (both from U of Ilinois - Urbana), H. Hora (U. of New S. Wales), and A. Scharmann (U. of Giessen), "Plasma-Surface Tension Model of Cold Fusion Reactions", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

NOTE: A similar paper is the following: H. Hora, L. Cicchitelli, G.H. Miley, M. Ragheb, A. Scharmann, and W. Scheid, "Plasma and Surface Tension Model for Explaining the Surface Effect of Tritium Generation at Cold Fusion", *Il Nuovo Cimento, Note Brevi*, Vol 12 D, No 3, pp 393-399, March 1990, in English, 16 refs.

SUMMARY
(of Il Nuovo Cimento article, courtesy of Dr. Hora)

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

COMMENTS

As a result of their model, Dr. Hora (who presented the paper) suggested that alternate layers of Ti and Pd or alternate layers of Fe and Th could enhance the fusion reactions.

During the question period, Dr. John Bockris objected to the use of the term plasma when the diffusivity in the Pd is of the order of 10^{-7}.

XU - DEUTERIUM DISTRIBUTION

Ji-an Xu (U. Hawaii), "D-D Distribution in $PdD_{0.4}$ at High Pressure", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

This short presentation by Xu described the distribution of deuterium in a Pd lattice when the D/Pd ratio is about 0.4 but the deuterium gas is under high pressures of 500 to 700 Kilobars. The data was obtained by X-Ray diffraction.

ANDERMANN - THEORETICAL MODEL

George Andermann (U. of Hawaii), "Theoretical Model for Low Temperature Nuclear Events", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

NOTE: In conversation with Dr. Andermann, he stated that this paper is closely related to a similar paper presented at the First Annual Conference of Cold Fusion on March 28-31, 1990 at Salt Lake City, Utah. The following information is extracted from that paper:

ABSTRACT

To date theoretical treatments of high energy nuclear events in electrochemically induced cold fusion in deuterium pressurized Pd cathodes have relied on a wide variety of models involving deuteron-deuteron fusion in spite of the forbidding Coulomb repulsion. No detailed nor satisfactory theoretical explanations have been offered for the low energy phenomena. The theoretical model proposed here is based on the formation of a new neutral particle, namely two bound neutrons, designated as Neutrium (Nu). It is postulated that Nu, under favorable conditions, may be absorbed by a deuteron to yield quatrium (Q), where Q decays to produce various high energy nuclear events. Nu can be shown to provide plausible explanations for the achievement or non- achievement of various high energy events. The model also calls for the possibility of Nu being absorbed by Pd or other heavy nuclei.

COMMENTS

The interesting speculation that palladium could absorb a Nu or a Q and produce a higher number isotope of Pd is subject to some experimental measurements. It will be interesting to follow the expected increased series of measurements of pre- and post-experiment ratios of Pd isotopes. Ed.

BRIAND - DEUTERIUM IN JONES Ti?

J.J. Briand, G. Ban, M. Froment, M. Keddam F. Abel (Laboratorie Physique Atomique of Nucliaire, France), "Is There Any Deuterium in Dr. Jones' Titanium Foils?", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

In performing experimental work on cold fusion, the authors did not achieve positive results. They did find that the D penetrates the Ti by only 1.2 micrometers. In

a spectroscopic analysis of the Ti cathode they found TiK, FeK, NiK, Fe^+, and Ni^+.

During the question period Dr. Jones responded that the Pd coats the Ti and helps the deuterium to penetrate the cathode. See the proceedings for more details.

BUSH - FURTHER THEORY DEVELOPMENT

Robert T. Bush, (Cal State Poly - Pomona) "Cold 'Fusion'; the Transmission Resonance Model Fits Data on Excess Heat, Predicts Optimal 'Trigger' Points, and Suggests Nuclear-Reaction Scenarios", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

ABSTRACT

The transmission resonance model (TRM) previously introduced is now combined with some electrochemistry of the cathode surface and found to provide a good fit to new data on excess heat: For the first time, a model for cold fusion not only fits calorimetric data, but also predicts optimal "trigger" points. This suggests both that the model is meaningful and that the excess heat phenomenon claimed by Pons and Fleischmann is real. A crucial role is suggested for the "overpotential" and, in particular, for the "concentration overpotential"; i.e. "hydrogen overvoltage". "Self-similar geometry", or "scale invariance", i.e. a "fractal" nature, is revealed by the relative excess power function. Heat "bursts" are predicted with a scale invariance in time, suggesting a link between cold "fusion" and Chaos Theory. The model describes a near-surface phenomenon with an estimated excess power yield of about 1kW per cu cm of palladium, as compared to 50 W per cu cm of reactor core for a typical fission reactor. TRINT (Transmission Resonance-Induced Nuclear Transmutation), a new type of nuclear reaction is strongly suggested with two types emphasized: Trint (Transmission resonance-induced neutron transfer) reactions yielding essentially the same end results as Teller's hypothesized "catalytic neutron transfer", and a three-body reaction. The cross-section sigma, for the nuclear reaction that is the ultimate source of the excess heat, is estimated to satisfy 10^{-29} per sq. cm. < sigma < 10^{-20} sq. cm. A possible light water excess heat effect is also suggested, but with a yield having an upper limit only 18% that for heavy water. Suggestions for the "anomalous:" production of heat, particles, and radiation are given. A polarization conjecture leads to a derivation of a branching ratio of 1.64 x 10^{-9} for the D-on-D reaction in electrolytic cold "fusion" in favor of tritium over neutrons. The model can account for the Bockris curve, in which a lower-level production of tritium mirrors that of excess heat. Heat production without tritium is also accounted for, as well as the possibility of tritium production without heat. Thus, the TRM has a high probability for unifying most, if not all, of the seemingly-anomalous effects associated with cold "fusion".

COMMENTS

As Bush concluded in his previous presentation: "The transmission resonance model appears to account for the Pons-Fleischmann effect of excess heat production. The model gives an excellent fit to data, strengthening the likelihood that it is correct, and boosting the credibility of the effect, itself. Nevertheless, the results indicated must be confirmed by other researchers. That the transmission resonance model stands a good chance of explicating both the phenomena of low-level neutron production and the higher-level production of tritium is very apparent; there is much work remaining to be done in order to sort this out. Finally, if the model is correct, it appears that there is little new physics involved. Rather, the Pons-Fleischmann effect is, quite simply stated, the most startling of the consequences of the wave nature of matter discovered thus far.

Dr. Bush's presentation is an advance over his first cold fusion theory paper [1]. Much attention has been given to the particle nature of possible cold-fusion nuclear reactions. Bush's approach in dealing with the wave nature of such reactions in the presence of the regularities of a crystal lattice has considerable merit.

His suggestion that the following reactions should be considered is challenging:

$^6Li + D \rightarrow 2\ ^4He + energy$
$^7Li + D \rightarrow {}^6Li + T + energy$
$D + Pd^n \rightarrow Pd^{n+1} + proton.$

In his Hawaiian presentation, Dr. Bush showed the result of one of his equations gives the value of 1.64 x 10^{-9} for the neutron/tritium branching ratio that would be expected to be found. This value is, indeed, close to the many measurements that have been and are being made of the cold fusion D-D branching ratio. See, for example, the review of the work done by Claytor, et al. at Los Alamos under the lead article of this issue.

Dr. Bush is to be congratulated on the progress that he has made in the development of his theory. His paper should be studied carefully by all sincere cold-fusion experimenters. Would someone please instruct *Fusion Facts* as to how this theory fits with the molten salts cold fusion? Ed.

HURTAK - HOT WATER HEATER

J.J. Hurtak (Hawaiian Co.), "Industrial Applications of Cold Fusion", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

Mr. Hurtak presented a video report on cold fusion given by an EPRI representative. Then Mr. Hurtak described a specific application for a future hot water heater using cold fusion. The marketing figures show that the hot water heater market for residential, commercial, and industry is about $6 billion annually.

NOTE: It was rumored that soon after the Pons-Fleischmann announcement, the patent office received over 50 patent applications for the "invention" of a cold-fusion powered hot water heater. Ed.

DINI - FAR FROM NOW

Dino Dini (Italy), "Why 'Cold' and 'Warm' Fusion Reaction Plants for Producing Useful Energy are Very Far From Now", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

The message from Dini was to use hydrogen as a fuel now. Hot fusion will not be commercial in less than a century, because there are so many difficult technical problems. Dini did submit that cold fusion could be in use within a hundred years.

NOTE: If you want to be wrong, predict what can't be done or when. This editor expects commercial uses of cold fusion within 2 to 3 years. Ed.

YANG - HEAT AND TRITIUM AT R.O.C.

Courtesy of Dr. C.S. Yang

C.S. Yang, C.Y. Liang, T.P. Perng, L.J. Yuan, C.M. Wan, and C.C. Wan (Materials Science Center, National Tsing Hua University, Hsinchu, Taiwan, 30043, R.O.C.), "Observations of Excess Heat and Tritium on Electrolysis of D_2O", *Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8*, Honolulu, Hawaii, July 23-24, 1990, in press.

This paper was one of the better papers given at the Hawaiian conference because it is only the second report on the simultaneous measurements of tritium and excess heat. In addition, the paper represents a real achievement in terms of replications of the Pons-Fleischmann electrochemical experiment. Six cells of six cells all produced excess heat.

Dr. Yang provided us with a copy of his paper. It is reviewed in some detail in this issue under the FUSION NEWS FROM ABROAD. Ed.

The next Hydrogen Energy Conference will be held in two years in Paris.

* * * * * * * * * *

E. OTHER NEWS FROM U. S.

LOS ALAMOS - TRITIUM PRODUCTION

T.N Claytor, P.A. Seeger, R.O. Rohwer, D.G. Tuggle, and W.R. Doty (Los Alamos National Laboratory), *Technical Information Release LA-UR-89-3946*, an unclassified report presented at the NSF/EPRI Workshop on Anomalous Effects in Deuterated Materials, October 18, 1989, Washington, D.C. [accepted for publication in *Fusion Technology]*.

ABSTRACT

A solid state "cold fusion" cell was constructed to test for nonequilibrium D-D fusion in a solid. The stimulus for the design was the hypothesis that the electrochemical surface layer in the Pons-Fleischmann cell could be replaced with a metal-insulator-semiconductor (MIS) barrier. Cells were constructed of alternating layers of palladium and silicon powders pressed into a ceramic form and exposed to deuterium gas at 110 psia resulting in a D\Pd ratio of 0.7. Pulses of current were passed through the cells to populate nonequilibrium states at the MIS barriers. One cell showed neutron activity and had a large amount of tritium. Other cells have produced tritium at a low rate consistent with neutron emission at or below the threshold of observability. The branching ratio for n/p was about 3×10^{-9} in all experiments where a substantial amount of tritium has been found.

CONCLUSIONS

Although the exact mechanism of fusion in the solid state is not known, our results support other measurements that find low values for the branching ratio. This work suggests an upper limit on the n/p ratio of 3×10^{-9}.

The main explanations for D-D fusion in the solid state are microcracking resulting in hot fusion, enhancement of tunnelling caused by increased electron shielding resulting from high local lattice pressures (piezofusion), nonequilibrium electron concentration (perhaps at defects), and high D/Pd concentrations. All reported

measurements indicate a very low branching ratio, discrediting the cracking hypothesis. Also, since no time correlation was observed with electron injection, one can tentatively dismiss the idea of nonequilibrium, electron-aided fusion caused by injected conduction-band electrons. The possibility still exists of some site-specific fusion where the local electron concentration is high. The idea of piezofusion or locally high lattice pressures caused by phase transitions or deuterium drift cannot be discounted.

Solid-state fusion cells appear to be an alternative to the electrochemical cell approach for the investigation of anomalous effects in deuterided materials. Because of the simplicity of the cell and the possibility of creating monolithic, layered structures, efficiency can be improved considerably. Based on the power input and the amount of tritium produced in cell 2, a factor of 10 improvement in efficiency would result in economic tritium production. The reduction in thickness of the silicon layers, the elimination of the hydrogen in the deuterium and palladium, and an increase in the gas pressure of the cell may improve the efficiency.

COMMENTS

In a private discussion with the author, the following information was obtained: This approach to tritium production has since been replicated in three separate cells. The paper notes the following: "The voltage and current pulse was 1 microsec to 1 millisec in width at up to 3,000 volts at currents as high as 0.5 amperes with a low duty cycle (such as 10 millisec). Usually, the pulse width and duty cycle were adjusted so that 1 Watt was dissipated in the cell.

Of course the great importance of these experiments are the following:

1. Proving the hypothesis that the electrochemical surface layer in the standard Pons-Fleischmann cell could be replaced by a metal-insulator-semiconductor barrier.

2. That a properly designed cell could be replicated with similar results.

3. That the tritium/neutron branching ratio is much larger than the 50/50 branching ratio at high temperatures and pressures.

Claytor and his fellow scientists are to be highly commended for their strong contribution to further the understanding and development of nuclear reactions in a deuterium-palladium system. Ed.

Dr. Sam Faile also talked to Dr. Claytor and makes the following comments: "The cell resistance was largely controlled by the 10 to 20 Angstrom thick silicon oxide layers. A number of cells with about 18 variations were built from April 12, 1989 to January 1990. The cell with the largest output produced 9,500,000 neutrons and about 35 x 10^{15} tritium atoms. The efficiency of tritium production was 0.3%. The solid-state fusion cells offer an advantage of simplicity and possible improvements involving monolithic-layered structures. Of particular interest is the cell which had the highest output of neutrons because 5% hydrogen was added to the cell. Some theories have hydrogen producing most of the energy with the deuterium in a mainly supporting [or catalytic] role. A systematic study is suggested in which various mixtures of hydrogen and deuterium are explored."

COMMENTS ON CLAYTOR'S ARTICLE

By Dr. Dennis Cravens

It's important to note that the branching ratio (3 x 10^{-9}) found here by gas loading is consistent with those seen in electrochemical cells. This factor has been a major sticking point for opponents to cold fusion who say the branching ratio should be identical to that seen in hot fusion reactions (i.e. n/p ratio = 1). The 10^{-9} ratio is clear evidence that some unique nuclear events are taking place within or on the metal lattice.

It is also interesting to note that a dynamic condition is required to produce tritium and neutrons. All production of tritium to date has involved some dynamic movement of deuterium within a loaded background lattice. The fact that tritium is not produced until the cell is discharged shows that fallacy of developing theoretic models based solely on the static positions of D within the loaded metal lattice.

Personal talks with the author reveal that both the metal host and the containment vessel must be scrupulously cleaned to get good yields from gas loading experiments. For example, yields can be greatly enhanced from temperature cycled gas-loaded Ti experiments if the vessel and components are cleaned, heated and vacuum out gassed before deuterium loading.

CORNELL U. SETS UP COLD FUSION ARCHIVE

Professor Bruce Lewenstein, Department of Communications, at Cornell has been involved as a Science Historian to study the development of cold fusion. Under a small grant from NSF, Dr. Lewenstein has interviewed many of the cold fusion scientists.

Elaine Engst is the archivist in the Olin Library at Cornell. Her number is (607) 255-3530. She reports getting several calls a day from various parts of the U.S. A brief article appears in *C & E News* on August 6, 1990, about this activity. *Fusion Facts* is sending a complete set of its first year's publication (Vol 1, Nos 1 through 12).

U OF PITTSBURGH - HYDROGEN CAPACITY

Courtesy of Dr. Sam Faile

D. M. Gualtieri and W. E. Wallace (Chem Dept, U of Pittsburgh), "Hydrogen Capacity and Crystallography of $ErFe_2$-based and $ErCo_2$-based Ternary Systems", *Journal of the Less-Common Metals*, Vol 55, pp 53-59, 1977 (Received December 7, 1976), 4 refs.

SUMMARY

The hydrogen capacity of the C15 Laves-phase alloys $ErFe_{2-x}Al_x$ (x = 0-0.6), $ErFe_{2-x}Mn_x$ (x = 0-1.4), $ErFe_{2-x}Co_x$ (x = 0 - 2.0) and $ErCo_{2-x}$ Ni_x(x = 0 - 2.0) was measured at 25 degrees C and 525 lb in^{-2}. Lattice parameters of the alloys and their hydrides were also measured. Al substitution for Fe decreases the hydrogen capacity of $ErFe_2$. Mn substitution for Fe in $ErFe_2$ increases the hydrogen capacity considerably, with a maximum hydride composition $ErFe_{0.8}Mn_{1.2}H_{4.6}$. Hydrogen concentration in this alloy exceeds 7 X 10^{22} atoms cm^{-3}. Co substitution for Fe in $ErFe_2$ first increases and then decreases hydrogen capacity, the maximum hydride composition being $ErFe_{1.2}Co_{0.8}H_{4.2}$. Ni substitution for Co in $ErCo_2$ has little effect on the hydrogen capacity of the alloy, although a large Ni concentration results in an increase in the equilibrium pressure. Lattice expansion is observed to correlate with hydrogen concentration for the group of systems $ErFe_2$-H, $ErFe_{2-x}$ Al_x-H and $ErFe_{2-x}Mn_x$-H. The maximum hydrogen capacity in the $ErFe_{2-x}Co_x$ system occurs at the same Co:Fe ratio, which gives the maximum Fe moment in these ternaries.

CONCLUSION

For the alloys investigated, hydrogen capacity appears to be a function both of lattice volume and of electronic effects. Al substitution for Fe in $ErFe_2$ expands the C15 lattice, but the hydrogen capacity is decreased. Mn substitution expands the C15 lattice and increases the hydrogen capacity dramatically. Co substitution decreases the C15 lattice volume, but the hydrogen capacity is increased, the increment correlating with the enhancement of the Fe magnetic moment.

COMMENTS

Although this article is over a decade old, it has been cited here because of the continuing intense interest in metal hydrides. The article relates that the peak of hydrogen capacity was coincident with a peak in the magnetic moment of Fe atoms in the ternary composition. The authors state, "This concurrence suggests that the enhancement of hydrogen capacity in this system may be a consequence of an enhanced capacity of the transition metal sublattice to accept electrons from hydrogen atoms."

U OF PITTSBURGH - CONTROL OF HYDROGEN ABSORPTION

Courtesy of Dr. Samuel Faile

D.M. Gualtieri, K.S.V.L. Narasimhan, and T. Takeshita (Chem. Dept. U/Pittsburg), "Control of the Hydrogen Absorption and Desorption of Rare-earth Intermetallic Compounds", *Journal of Applied Physics*, Vol 47, No 8, August 1976, pp 3432-3435, 8 refs.

ABSTRACT

The rate at which rare-earth intermetallic compounds absorb and desorb hydrogen can be controlled by "poisoning" the catalytic reaction, H_2 <--> 2H. Specimens treated with SO_2, a well-known catalytic "poison", are prevented from absorbing hydrogen for extended periods. More surprisingly, SO_2 treatment after hydrating prevents hydrogen desorption by specimens for weeks. The applications of this process to energy storage are numerous.

DISCUSSION

The effect of SO_2 on the hydrogen absorption and desorption rates of rare-earth-transition-metal alloys seems to confirm the catalytic poisoning of reactions (H_2 --> 2H and 2H--> H_2) on the alloy surface. This suggests that other catalytic poisons may be as effective as, and perhaps more useful than, SO_2 in slowing both the absorption and desorption rates of hydrogen. Since it is thought that the eventual absorption or desorption of the hydrogen in the SO_2-treated alloys is caused by a slow thermal desorption of the adsorbed SO_2 molecules, storage of treated specimens at low temperatures may enhance the poisoning effect. Thus, SO_2-treated superconducting hydrides might maintain a long service-life if kept at cryogenic temperatures. The reported degradation of the rare-earth permanent magnets upon prolonged exposures to air, presumably due to absorption of hydrogen, may be prevented by a suitable poisoning treatment.

COMMENTS

Here again this is an old article but has considerable merit for cold fusion experimenters to help in the understanding of some of the parameters that can enhance and/or degrade cold fusion experiments. *Fusion Facts* would welcome an article and/or comments about the "promoters" and/or "poisons" found to be important in cold fusion experiments. Ed.

FOR RUMOR MONGERS

It is rumored that one enterprising government worker has been informed that he is not expected to work on "Cold Fusion". So now he is doing some of his work on "Experimental Measurements of Nuclear Reactions".

Morrison is still perpetuating the myth that cold fusion is pathological science. However, he has to ignore an increasing volume of positive results. He is using a marvelous "filter" to evaluate his data. Is someone paying Morrison to discredit this new science? If so, they are playing a zero-win game.

The patent office is stirring. Two of our friends have had letters from the patent office. One was a turn down and the other was a request to resubmit an invention disclosure into more than one invention disclosure.

A group at an uncited power company estimates that $100 million in research funds are being spent annually on cold fusion research and development. We can account for about $20 million in the U.S. if we estimate the value of the "bootleg" R & D that is going on in many corporate, government, and university labs. Much of this research is not being reported (not even to *Fusion Facts*).

Dr. Sam Faile reports on a rumor that Japan is checking cold-fusion with a large underground particle detector. Dr. Faile asks, "Are they looking for neutrinos?"

* * * * * * * * * *

F. FUSION NEWS FROM ABROAD

TAIWAN - R.O.C. - HEAT AND TRITIUM

Courtesy of Dr. C.S. Yang

C.S. Yang, C.Y. Liang, T.P. Perng, L.J. Yuan, C.M. Wan, and C.C. Wan (Materials Science Center, National Tsing Hua University, Hsinchu, Taiwan, 30043, R.O.C.), "Observations of Excess Heat and Tritium on Electrolysis of D_2O", Presented at the Cold Fusion Symposium, World Hydrogen Energy Conference #8, July 23-24, 1990, Honolulu, Hawaii.

ABSTRACT

The electrolysis of D_2O + O.1N LiOD was conducted with quartz cells. The heat generated was transferred to a water bath. Before the test, the bath temperatures due to various input powers had been carefully calibrated for cells utilizing Pd or stainless steel cathode or for bath directly heated by a resistor heater. After different periods of charging, excess heat and enrichment of tritium were observed in several cells. The excess heat amounted to 100% at an input power of about 10 W, but became smaller (20-40%) at higher powers. Tritium in the electrolyte was enriched by one to two orders of magnitude. When excess heat occurred, the duration of reaction could be extended by slightly increasing the input power.

CONCLUSIONS

Excess heat and tritium in the same cells was observed on the electrolysis of D_2O with Pd. The excess heat could be extended by successive increase of the input power. The excess heat amounted to 100% at an input power of about 10 W but became smaller (10-40%) at higher powers. Tritium in the electrolyte after electrolysis was enriched by one to two orders of magnitude.

COMMENTS

Many scientists have tried the above experiments but with unsatisfactory results. In a conversation with Dr. Yang it was found that the differences between the "standard" cold fusion electrochemical cell experiment and Dr. Yang's work is the following:

1. Yang used quartz containers for the electrochemical cells.

2. Yang obtained the Pd and LiOD from a Japanese chemical supply company.

3. Yang observed that the gradual reduction in excess heat could be restored by the gradual increase in voltage (ramp up as contrasted to step up.)

The time constant of the calorimeter is large so that the experimenters would allow for about 24 hours between measurements to assure that steady-state values had been achieved. They developed a workable plan in which the cell voltage would be increased by one volt (gradually) during the night shift and the temperature and tritium measurements would be made during the day. The schedule then became a daily increase of the input power to each cell.

The following quote from the author's paper, "If the excess heating was about to decrease, it could also be

recovered by slightly increasing the cell voltage." This careful observation suggests that the cathode or the cell is becoming modified by its operation and that this modification is overcome by an increase in the voltage to the cell. Could this be a coating on the cathode that is reducing a surface reaction?

Dr. Yang reported that future work will include experiments with closed cells. Figures 3 and 4 from Yang's paper are copied below. Note that the data is generally taken at increased input power on successive days. It is deemed an important finding that the temperature rise (above that obtained for the calibration curves) is approximately constant. As the power is increased, the power output of the working electrochemical cell appears to provide sufficient additional energy to raise the temperature of the calorimeter bath by about the same amount on successive days (using one volt daily increases in input voltage). These data seem to imply a relatively steady-state condition (same temperature rise) superimposed on a dynamic condition that is overcome by daily increases in input cell power. Comments from readers are encouraged. Also, it is obvious that experimenters should try the daily increase in power to see if they obtain the same results. Ed.

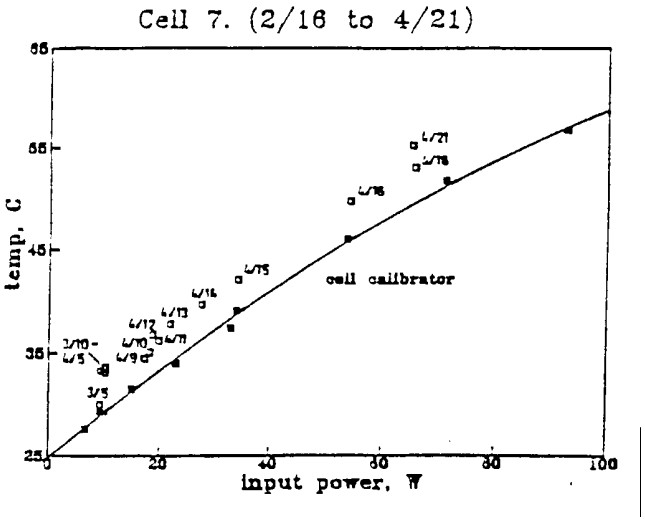

Fig. 3 Chronological Bath Temperatures for Cell #7

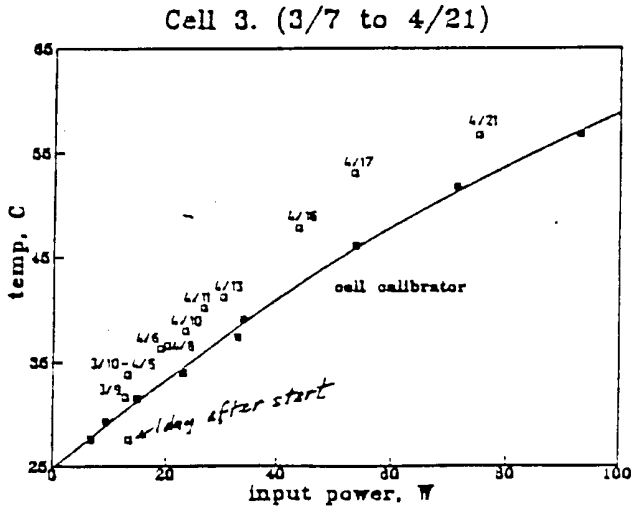

Fig. 4 Chronological Bath Temperatures for Cell #3.

INDIA - A MATERIALS BOOK REVIEW
Courtesy of Arunachalam

Subbiah Arunachalam, Book Review Section of the following book. Printed in *Indian Journal of Technology*, Vol 28, Nos 6-8, June-August 1990. [This book review is considered to be of some interest for our readers who are beginning to design commercial cold fusion applications and who want to be aware of the latest materials. Ed.]

Jon Binner, Paul Hogg, and John Sweeney (editors), *Advanced Materials Source Book*, Elsevier Advanced Technology, Mayfield House, 256 Banbury Road, Oxford, England c1990, 367 pages, price 135 pounds sterling.

REVIEW

The volume under review fits in with this prescription rather well. The chosen materials are relevant now and some of them are even state-of-the-art. The title alas is misleading: this is not **the** source book on Advance Materials. The scope is restricted: For instance, there is no coverage of metallic materials; nor is this a data source book. Instead, I would like to classify this volume as Advanced Materials Information Source book. This name fits in with the contents of the volume well.

The volume is edited by three authors and they discuss three topics: ceramics, plastics, and composites. I am happy with the choice, for one could have chosen more

topics and make either the volume bulky and unbuyable, or dilute the discussions to a more peripheral level. The presentation is also different and novel. This is not a mere handbook citing some data or another; instead, it discusses the development of technologies related to the topic, and also tells us where to dig deeper for more information. Relevant company addresses are very liberally provided as also information on reports on these subjects. Any researcher though will be staggered by their costs: For instance, a report on polymer matrix composites costs about $2650! I suspect these are aimed more at financial institutions and venture capitalists who are interested in the materials market.

The chapter on ceramics is a good one with even a section on high temperature superconductors. This is welcome as most of the reviews on ceramics merely emphasize the potential of advanced structural ceramics glossing over the toughness problem. Until this vexed question is solved either through design or by incorporation in composite structures, these materials will continue to be shunned by designers and investors alike. This chapter quotes a reviewer from the Financial Times Business Information as concluding that money spent in advanced ceramics can be better spent elsewhere. Who can question him?

There is an excellent section on electronic and laser materials and this should be of interest because of the use of lasers in optical and electro-optical products in industry. There is also a section on services that are available for ceramics research for materials characterization and also on company takeovers and mergers.

The chapter on plastics follows the same style with an emphasis on new engineering plastics and also their processing. There is an excellent section on the processing of composites with polymer matrix and this discusses in brief paragraphs the processing of thermoplastics and the development of pultrusion technique. There is also a mention on surface treatments that enhance adhesion as also on processing aides. All these discussions are alas too brief, whetting one's thirst, but not quenching it: the reader must look elsewhere for more details. The section on applications deals with the routine and perhaps easy-to-replace components of the automotive industry with the more esoteric and complex parts reserved for the aerospace.

The chapter on composites is similar, emphasizing recent trends and emerging applications. The state of the industry throws some interesting sidelights, with Japan (who else?) dominating most of the programmes on resin-matrix composites and the United States concentrating on metal-matrix and on carbon-carbon systems. Incidentally, the latter material is being evaluated as a contender for the National Aerospace Plane (NASP). The only problem in realizing the full potential of this excellent material is the high temperature oxidation. But there is news in this volume about coating this material. That should make it more popular for many other applications.

Polymer matrix composites with thermoplastics are becoming more popular compared to the earlier thermosetting plastics. This may be more due to their increased high temperature capability which broadens their applications. There is also a section on metal matrix composites. Perhaps these materials could have been discussed more; but, then, the results available to date may not warrant all that enthusiasm. The industrial application of all these materials seems to be more in the aerospace industry where weight is a major concern. Given the unique advantage of the composites, the reviewer suspects that the vicissitude of the aerospace industry will govern the growth of this class of materials, if you do not include the more popular applications in tennis rackets, golf clubs or fishing rods.

INDIA - A U.S. REPORT

Courtesy of S. Arunachalam

The pioneering cold fusion paper by M. Fleischmann and S. Pons that appeared in the *Journal of Electroanalytical Chemistry and Interfacial Electrochemistry,* (Vol 261, dated 20 April 1989, pp 302-308) received 29 citations in the international journal literature during the two months of January-February 1990, says a report from the Institute for Scientific Information, Philadelphia. That makes it the tenth highly cited paper in physics among papers published since January 1988. During November-December 1989, the Fleischmann-Pons paper was ranked fourth in terms of number of citations received, and commenting on this decline in the number of times cited, *ScienceWatch,* ISI's monthly newsletter tracing trends in basic research, says: "....and the Fleischmann-Pons cold-fusion bombshell which has dropped from fourth to tenth, seems to be sinking along with the hopes of many cold-fusion enthusiasts". (See *Sciencewatch*, May 1990, pg. 6).

NOTE: It is interesting how eagerly some are to predict the end, demise, or the coffin nails for cold fusion. Those predictors are engaged in a misallocated desire. Ed.

INDIA - ALKALI HYDRIDE

Courtesy of Dr. Samuel Faile

M. S. Ali and M. M. Hasan (Dept. of Physics, Bhagalpur University, Bhagalpur, India), "A New Interaction

Potential and lkali Hydride Molecules" *Indian Journal of Physics*, Vol 63B (4), 486-490, 1989, 8 ref.

ABSTRACT

Theoretical evaluation of molecular properties of diatomic ionic molecules are made through an analysis of interionic forces viz. Coulomb interaction ($-e^2/r$), polarization forces, Van der Waals (vdw) interactions ($-C/r^6$) and short-range repulsive interactions. The earlier workers (Klemperer and Margrave 1952 and Varshnia and Shukla 1963) have concluded that the combined effects of polarization and vdw energies improve the results of binding energy but worsen the results of spectroscopic constants for alkali hydrides. In the present work, we are to study only the contributions of vdw interaction in these molecules.

ENGLAND - *NATURE* ON COLD FUSION

Staff, "Cold fusion and other matters", *Nature*, Vol 346, No 6282, 26 July 1990, pp 326.

The article is a staff-written book review of "The Grant Swinger Papers", 2nd edn. *Science & Government Report*, 6226 Northwest Station, Wash D.C. 20015: 1990 pp 40, $8.95. The reviewer quotes the following as an example of the best in innovation for science to obtain funding: "Cold fusion. An exemplary case in the best tradition of the Center for the Absorption of Federal Funds. If I have any concerns, they're directed at my own institution for not doing it first. Think of it: no publication, just a press conference. And they get $5 million from the Utah legislature. Jim Fletcher, the ex-chief of NASA, joins up with them, and over a hundred corporations line up and plead for a piece of the action. It's on the covers of *Time* and *Newsweek*, and Congress invites them in to talk about $25 million. And if there's anything there, no one can find it! This is a triumph. We've worked for years to get the Congress, the press, and the public to this stage.

NOTE: Amazing that this prestigious science publication can consistently avoid the reality of the most important new science discovery made during *Nature's* history?

* * * * * * * * * *

G. LETTERS FROM READERS

GENERAL: We are pleased with the many letters and calls that we have received about *Fusion Facts* (especially about the June 1990 issue summarizing the successes that have been made in cold fusion). We apologize that we did have some errors in our charts which are being corrected and will be republished. Please note the following: In the chart of tritium, the Iyengar & Srinivasan tritium amount was shown as 78 and should be 10^7 to 10^8. Also the Bockris tritium finding of $6x10^6$ should be moved left to May 1989. Now, if we can just get someone in the Bush administration to learn of the tremendous potential of cold fusion, President Bush could augment his comments about methanol and windmills with some REAL alternative energy potential. Ed.

MORE FROM DR. WILL IN SEPTEMBER

Dr. Fritz Will, Director of the National Cold Fusion Institute (U of Utah Research Park) writes the following, "I am looking forward to talking with you about my recent trip to Japan and India. There is much of a positive nature to share, however my available time before I leave for the Gordon Conference is so short it hinders me in this respect. ... Best wishes to you in your continuing success with *Fusion Facts*."

CURRENT IN PALLADIUM CATHODES

By Andrew E. Huber (Retired Reliability Engineer)

Suppose we have a cathode, suspended longitudinally in a standard Pons-Fleischmann cold fusion cell, with the battery connection at top center of the cathode. With the cathode connected to a negative voltage, let's consider the path that positive charge, uniformly distributed over the rod surface, takes to reach the connection. As a first approximation we can draw straight lines from every point of the surface to the battery connection at the top center of the cathode. Since moving charges of the same polarity, and which are moving in the same direction, tend to attract; the charges tend to come together, all the while moving upward.

Suppose the point connection to the top of the cathode is replaced with a disc which is part of a multilayer substrate. Let the disc cover the entire top surface of a cathode and assume it establishes a uniform electric field. Once again the surface charge moves toward the core of the rod as it moves upward. Suppose the disc is replaced with four point connections, with each point located on the periphery of the top surface of the cathode and spaced 90 degrees apart. Let each of the four points be connected to a resistor whose characteristics are: 3 1/3 ohm, one percent, 30 watt power dissipation capability. Let the leads of the four resistors be connected together and then connected to the battery. Let us assume that the total current that flows to the battery is 4/6 amperes.

The current that is collected by the surface will flow through the resistors in approximately equal amounts, as determined by the tolerances of the resistors. The voltage drop across each resistor will be approximately 3 1/3 ohm

X 1/6 ampere = 10/18 volts. The power dissipation of each resistor will be approximately 10/108 watts. The resistors employ a form of feedback that adjusts the electric fields at the top of the rod. The circuit, in general, requires that the voltage drop across the resistors be very much larger than the voltage between points on the rod, or alternately, that the resistances of the external resistors be very much greater than the resistances between points within the rod. The feedback would use voltage and dissipate power. Once again the surface charge moves toward the core of the rod as the charges move upward.

Suppose the precise electrical characteristics of the top connection are unknown. A spot weld fits this description. A brazed connection fits the description, as does a cliplead connection. For these cases one can still say that, in general, the current density throughout the rod is a variable, and is greater near the battery connection than on the surface. If it is assumed that the surface current density is 64 mA per sq cm, one can expect the electrical connection to the cathode will result in current densities of about 640,000 mA per sq cm or greater in the vicinity of the connection.

The implication is that if high current density is one of the factors associated with one or more of the cold fusion nuclear reactions, then perhaps only a small portion of the rod is generating the excess heat.

The example of the four resistors loosely defines the electrical requirements for a substrate. The example of the disc substrate illustrates that shape can also be a factor in defining current density.

COMMENTS

Huber's illustration may have considerable merit. We have noted that some of the more interesting results in the production of excess heat have involved the use of a cell configuration that differed in some measure from the original Pons-Fleischmann configuration. Ed.

NOTE FROM BOCKRIS

Chi Cho Wan is Dean and Professor at the National Tsing-Hua University in Hain Chu, Taiwan, 30043. I was recently told that he has produced tritium. I think that is quite important. Thought you would like to know. From John Bockris, Dept. of Chemistry, Texas A & M University.

COMMENTS

This is an example of the kinds of leads that help us to make *Fusion Facts* a more useful publication. The work from Taiwan is reported in this issue and also highlighted in a recent press release (See the article beginning on page 1, "To Nuclear Physicists: Cold Fusion Proven".) Although we do not thank them often enough, it is our readers and our correspondents that deserve the credit for the success of *Fusion Facts*. Thanks readers and correspondents. Ed.

* * * * * * * * * *

H. SHORT ARTICLES ON FUSION TOPICS

COMMERCIAL SIGNIFICANCE OF FUSED SALT ELECTROLYTES

by Dr. Dennis Cravens

The recent public announcement of B. Liebert, B. Y. Liaw, P. Tao, and P. Turner of the University of Hawaii represents both an important scientific claim and a significant engineering milestone. This is due to three factors: 1) the claim of increased excess heat, 2) the possible increased efficiency of energy production, and 3) the increase of feasible power densities. The first point is easily seen. The U of Hawaii team has reported that a cell requiring 5 Watts of input electricity generated up to 25 Watts of thermal energy for considerable lengths of time. The key to the approach has been to use fused salts as the electrolyte instead of heavy water. This approach has allowed them to work at higher temperatures. Although there is no leading theoretical model, several theories (for example, Bush [1]) indicate that increased temperatures should yield higher percents of excess heat. The common thread in those models has been to treat the effect as a dynamic one instead of a static equilibrium matrices of PdD.

The other important factors depend on the elevated operational temperatures. In the molten salt approach, the working temperatures are between 300 and 400 C. Several very important things happen when you can raise the working temperatures of a power plant. First, the power plant becomes more efficient. In this case the efficiency is in addition to any gains related to the increases in percent excess heat production. That is, it turns a larger fraction of available heat into its output. This means that the heat exchanger can be made smaller because it handles less waste heat. Further reduction in the heat exchanger size is possible because less area is needed to transfer heat at the higher temperatures. In addition, the higher temperatures allow a faster transfer of energy from any heat source to its sink. This ultimately allows for greater power densities.

The engineering advantage can be seen from the Carnot equation. Carnot found that the efficiency of a heat

engine was determined by the hottest (T_h) and the lowest (T_l) temperatures in the engine. That is

$$e = \frac{T_h - T_l}{T_h} = \frac{\text{heat out}}{\text{heat in}}$$

If we were limited to a heavy water electrolyte, then the difference in temperature would greatly limit the ultimate efficiency of any dynamo (say steam turbine and generator) we connect to the fusion cell. The reason is that the upper practical temperature for a heavy water electrolyte would be near 200°C. Attempts to contain steam pressures above that would not be practical in a commercial setting. However, the 300-400°C for molten salts would not cause such pressure difficulties. In fact, for a fused salt configuration the only limit to the cell's operational temperature seems to be the melting point of the cathode (Pd, 1552C). Even that limit could be stretched, since some people are proposing the use of high melting point alloys for the cathode.

The 600 to 1200% excess heat claimed by Liaw et al [2] represents an important advance. Since most steam turbine driven generators only convert about 1/3 of the input energy into electricity, any practical large scale commercial system would need excess heat percentages over 300%. Anything less than 300% would require less attractive engineering options such as megawatt level fuel cells.

In addition to the Carnot efficiencies, the increase in working temperatures allows for smaller and less costly commercial applications. The reason is that the heat exchanger can more easily transfer the waste heat to the environment. The area required by the heat exchanger is inversely related to the temperature difference between the fluid carrying the waste heat and the environment absorbing the waste heat (river, lake, air, cooling tower etc.)

REFERENCES

[1] Robert T. Bush, (Cal State Poly -Pomona) "Cold 'Fusion'; the Transmission Resonance Model Fits Data on Excess Heat, Predicts Optimal 'Trigger' Points, and Suggests Nuclear-Reaction Scenarios", Proceedings of the Cold Fusion Symposium, World Hydrogen Energy Conference #8, Honolulu, Hawaii, July 23-24, 1990, in press.

[2] Bor Yann Liaw, Peng-long Tao, Patrick Turner, Bruce E. Liebert (Univ of Hawaii), "Elevated Temperature Excess Heat Production Using Molten Salt Electrochemical Techniques", Presented at the Cold Fusion Symposium, World Hydrogen Energy Conference #8, July 23-24, 1990, Honolulu, Hawaii.

CHUBB - COMMENTS ON JULY ARTICLE BY WHITE

Reference: John N. White (Chapel Hill, N.C.), "A Protium to Deuterium Theory of Cold Fusion", *Fusion Facts*, Vol 2, No 1 pp 17-19.

Dr. Talbot A. Chubb comments on John White's protium to deuterium theory: White's theory is in the spirit of what is needed to explain cold fusion: quantum mechanics, delocalized states, wave function overlap, etc. My personal off-the-cuff feeling is that White's theory is incompatible with cold fusion observations. It is basically a weak force theory, involving both baryons and leptons, and weak force reaction rates turn out to be very low. Moreover, it doesn't fit the prime observation that deuterons seem to be required despite the higher protium loading achieved under chemical equilibration, as shown in Wicke and Brodowsky's summary paper on palladium hydride [E. Wicke and H,. Brodowsky in Hydrogen in Metals II, edited by G. Alefield and J. Volkl (Springer, Berlin, 1978) p. 73].

Our band state deuterium theory [1,2] is in much the same spirit as White's i.e is based on delocalized states, quantum mechanics and wave function overlap. But it depends only on the strong force and makes use of the bosonic properties of the deuteron, as emphasized by both Cravens and Westfall. Also the physics involved seems more straightforward since it follows from the many body wave function constructed in the same manner as used all the time in solid state electron physics. In reference to the other papers, I agree with Cravens when he says that greater temperature could enhance the cold fusion process but impairs loading, but disagree with Gryzinski about the role of electrons, and Westfall about the need for pairing to achieve bosonic behavior. After all, D^- is already a boson. (I may be misreading Westfall about the need for pairing, though he speaks of a fermi gas instead of a boson gas. His theory seems in some ways a bit like ours, especially with respect to the distributed Bose state ^4He product.).

Comments on my comments would be appreciated.
T.A. Chubb.

REFERENCES

[1] T.A. Chubb (NRL) and S.R. Chubb (Bendix), "Nuclear Fusion in a Solid via a Bose Bloch Condensate", NRL Memorandum Report 6617, Naval Research Laboratory, Wash D.C. 20375-5000, March 5, 1990.

[2] Scott R. Chubb and Talbot A. Chubb, "Quantum Mechanics of 'Cold' and 'Not-so-cold' Fusion", *The First Annual Conference on Cold Fusion, Conference Proceedings",* March 28-31, 1990, University Park Hotel, Salt Lake City, UT, published by NCFI, pp 119-129, 8 ref.

COMPUTER ELEMENTS FROM SOLID-STATE FUSION DEVICES?

By Dr. Samuel Faile

It is proposed that the use of alternating layers and heterojunctions in gas-loaded cold fusion devices could lead to switching devices and logic elements. If practical means can be found to turn cold fusion devices "OFF" and "ON" in microcircuit configurations, then it may be possible to design a computer capable of performing many parallel or autonomous operations. Various diode and triode properties could be enhanced or provide new functions as various levels of fusion reactions switched "ON" or "OFF". Avalanche effects that produce super energetic electrons or deuterons may find uses and stimulate the development of more robust theories of solid-state technologies involving new band concepts.

COMMENTS

Dr. Faile may want to include the use of solid-state deuterium/metal lattice systems as miniature power supplies for powering the computer. Ed.

* * * * * * * * *

COMING IN THE SEPTEMBER ISSUE

Fusion Technology, a Journal of the American Nuclear Society has devoted its August 1990 issue entirely to articles on cold fusion. These articles are:

1. Bockris et al. (Texas A&M), "A Review of the Investigations of the Fleischmann-Pons Phenomena."

2. Iyengar et al. (India), "Bhabha Atomic Research Centre Studies in Cold Fusion."

3. Arata et al. (Osaka U.), "Achievement of an Intense Cold Fusion Reaction."

4. Scott et al. (Oak Ridge Nat'l Lab), "Measurement of Excess Heat and Apparent Coincident Increases in the Neutron and Gamma-Ray Count Rates During the Electrolysis of Heavy Water."

5. Aiello et al. (Istituto Naxionale di Fisica Nucleare, Catania, Italy), "Nuclear Fusion Experiment in Palladium Charged by Deuterium Gas."

6. Bittner, et al. (Dresden U. of Technology)," Method for Investigation of Fusion Reactions in Condensed Matter."

7. Para, et al. (Instituto di Ingegneria Nucleare del Politecnico di Milano), "Neutron Monitoring and Related Measurements During Electrolysis of Heavy Water with Palladium and Titanium Cathodes: Activity Report."

8. Rafelski, et al. (U. of Ariz.), "How Cold Fusion can be Analyzed."

9. Tabet, et al. (Instituto Superiore di Sanita Laborartorio di Fisica, Rome), "A Dynamical Model for Cold Fusion in Deuterated Palladium."

10. Rice, et al. (Purdue Univ.), "The Role of Velocity Distribution in Cold Deuterium-Deuterium Fusion."

The above ten articles will be reviewed in our September 1990 issue of *FUSION FACTS.*

UPCOMING COLD FUSION CONFERENCES

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

Sponsored by the Utah Engineering Experiment Station with the support of The Mountain West Venture Group.
Friday, September 7, 1990 - University of Utah
A. Ray Olpin Union Building - Salt Lake City, Utah

Cold Fusion Connection

Dr. Hideo Ikegami, chairman and project leader of cold fusion research at the National Institute for Fusion Science in Japan will be a speaker.

The registration fee for the 1990 conference is $25 per person for the conference and luncheon; or $10 for the luncheon session alone. For registration, speaker, and agenda information, contact:

Utah Engineering Experiment Station
104 Engineering and Mines Research Office Building
Univesity of Utah, 84112 phone 801/581-6348.

ANOMALOUS NUCLEAR EFFECTS IN DEUTERIUM/SOLID SYSTEM

Sponsored by EPRI, BYU, Japanese National Institute for Fusion Studies, & U.S. DoE. Conference will be held at:
BYU, Provo, Utah - October 22 to 24, 1990
Interested attendees and contributors should send expressions of interest in the conference by or soon after June 20, 1990 to:

BYU CONFERENCES AND WORKSHOPS,
NUCLEAR FUSION
154 H.C.E.B.
Provo, Utah 84602
Phone 801/378-4851 (Nuclear Fusion Conf.)

Abstracts should reach Prof. Jones by Sept. 15, 1990.
Above information courtesy of Dr. Nate Hoffman of the Energy Technology Engineering Center who is the Conference Secretary.

FUSION CONCEPTS COURSEWARE COSTS
2-Diskette Set IBM-compatible.$ 95
Specify 5 1/4" or 3 1/2" Diskette

FUSION ANNOTATED BIBLIOGRAPHIES COSTS
Published on 5 1/4" or 3 1/2" Diskettes.
Includes **INFOFIND** search and retrieval program.
Three Volumes now available.
Each Volume.....$ 95

CONSULTING SERVICES
Consultation services can be used
to evaluate research proposals and also to define new business opportunities and/or declining
markets for specific industries.
(801) 583-6232

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

FUSION ASIA
C-9 Nizamuddin East
New Delhi 110013, India
$40 for 4 issues.

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

FUSION TECHNOLOGY
Recently added new section on Cold Fusion
555 N. Kensington Ave.
LaGrange Park, Illinois 60525
$310 for 2 volumes + 1 supplement.

FUSION FACTS STAFF AND CORRESPONDENTS

Hal Fox.....Editor-in-Chief
Paul Prows.....Departmental Editor
Christine Marshall.....Circulation

Technical Correspondents:
Subbiah Arunachalam, New Delhi, India
Dr. Robert W. Bass, Registered Patent Agent, Thousand Oaks, California
Dr. Dennis Cravens, Texas
Dr. Samuel P. Faile, Cinc, Ohio
Avard F. Fairbanks, Resident Snr. Engineer
Marsha Freeman, Washington, D.C.
Dr. Maurice B. Hall, Resident Snr. Physicist
Prof Wilford Hansen, USU Logan, Utah
Dr. Shang-Xain Jin, Beijing, China
Ramtanu Maitra, New Delhi, India
Dr. Takaaki Matsumoto, Hokkaido U., Japan
Dr. V.C. Noninski, Sofia, Bulgaria
Prof. Edward P. Palmer, BYU, Provo, Utah

CONFERENCE PROCEEDINGS AVAILABLE

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

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

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

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

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

FUSION FACTS SUBSCRIPTION COSTS

FUSION FACTS EACH ISSUED MAILED
FIRST CLASS.
12 ISSUES. . . . . .$ 345
36 ISSUES. . . . . .. $ 900
Single Evaluation Copy. . free

FUSION FACTS SINGLE ISSUES
CURRENT ISSUES EACH. $35
LAST MONTHS ISSUE EACH $20
3 MONTHS OR OLDER EACH $10
3 MONTHS OR OLDER ANY 3. . . . .$25

SUBSCRIPTION REQUEST

PLEASE SEND ME THE NEXT 12 ISSUES OF FUSION FACTS
(12 ISSUES - $345, 36 ISSUES - $900)
Send Fusion Facts to:

NAME:_____
COMPANY:_____
PO BOX, DEPT:_____

CITY:_____

STATE_____ZIP_____

Your check or money order should be made payable to Fusion Facts and sent to:

Fusion Facts
P.O. Box 58639
Salt Lake City, Utah 84158

Any questions or comments? Call, fax or write:
(801)583-6232
(801)272-3344 (fax)

FUSION FACTS is published by the Fusion Information Center, an independent corporation not affiliated with the University of Utah

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

SPECIAL SUBSCRIPTION OFFER

All new or renewed subscriptions received and paid for before September 30, 1990, will receive a full twelve month subscription to *Fusion Facts* together with the entire super-indexed Volume 1 (July 1989 to June 1990) of *Fusion Facts*.

12 issue subscription to *Fusion Facts*..$345.00

Mailed via airmail to all countries about the 15th day of the month of issue.

VOLUME 1 WITH **INFOFIND**.....$195
Specify 5 1/4" or 3 1/2" diskettes.