FUSION facts

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

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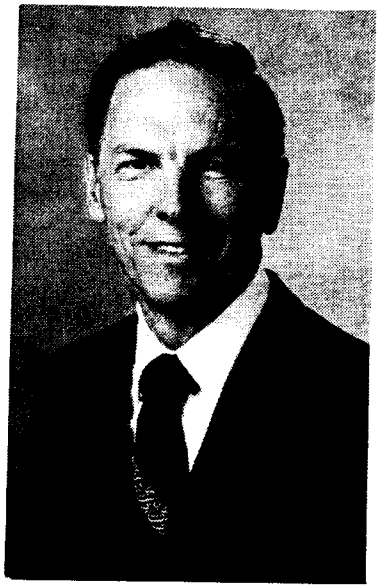
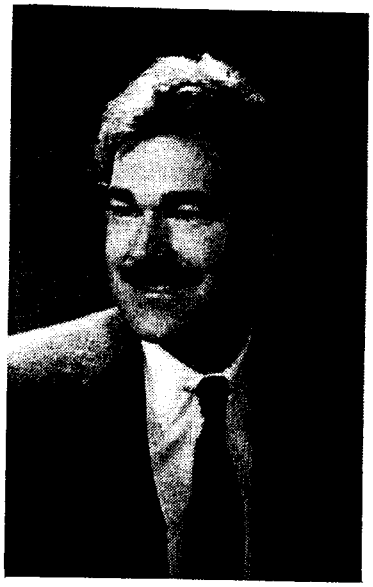
FUSION FACTS NAMES BUSH, EAGLETON, AND MILLS AS FUSION SCIENTISTS OF THE YEAR 1991

ROBERT T. BUSH



ROBERT D. EAGLETON



RANDELL L. MILLS

CONTENTS FOR JANUARY 1992

A. FUSION SCIENTISTS OF THE YEAR

Dr. Robert T. Bush, Dr. Robert D. Eagleton, & Randell L. Mills, M.D. NAMED "FUSION SCIENTISTS OF THE YEAR."

For meritorious achievements in advancing the technology of cold fusion and/or enhanced energy devices, *Fusion Facts* has awarded its "**Fusion Scientists of the Year**" award to two Professors and a Medical Doctor: Dr. Robert T. Bush and Dr. Robert D. Eagleton, both Professors of Physics at California State Polytechnic University (Pomona, California), and to Randell L. Mills, M.D., President of Mills Technologies (Lancaster, Pennsylvania.)

Dr. Bush is recognized for developing a **model** (the Transmission Resonance Model) of cold fusion which has predicted more experimental findings than any other model. Bush and Eagleton, the team, are recognized for achieving the most continuous output of power per cubic centimeter of Pd than any other published results. Mills is recognized for achieving the first announced development of a new energy source and successfully providing a kilowatt of heat energy from an electrochemical cell. Bush and Eagleton are further recognized for replicating and extending the Mills technology (using electrochemical cells with light water, potassium carbonate, platinum anode, and nickel cathode.)
We congratulate these three scientists for an excellent combination of theoretical and experimental work. They all agree that the newest electrochemical cells are replicable ("they all work now"), produce considerably more than 100% excess heat, and the technology can now be advanced. As an added bonus, all cells work with light water, relatively inexpensive cathodes, and inexpensive electrolytes. Congratulations! The world will be a better and cleaner world because of your efforts.

BACKGROUND INFORMATION

Dr. Bush received his Ph.D. in theoretical physics from Northwestern University in 1971. He was the youngest in his first-year graduate class at Berkeley and worked for a year with the History of Quantum Mechanics Project Group of Thomas Kuhn. Bush was the winner of both a Woodrow Wilson Fellowship in Physics and one in the History of Science. He is presently Professor of Physics at "Cal Poly" where he has taught for twenty-two years. Dr. Bush has also been an industrial consultant to General Dynamics.

Dr. Eagleton received his Ph.D. in experimental solid state physics from Oklahoma State University in 1969. He served on active duty as a line officer in the United States Navy from 1962 to 1965. During that time he was assigned to the U.S. Naval Nuclear Power Program. Eagleton is presently Professor of Physics at "Cal Poly" where he has been a faculty member since 1968. In addition to his teaching, Eagleton has developed the optics, modern physics, and advanced instructional laboratories.

Randell L. Mills, M.D. graduated Summa Cum Laude in Chemistry at Franklin & Marshall College in 1982 and graduated from the Harvard Medical School in 1986. While doing his intern work, he also went across the river to MIT and furthered his education with electrical engineering courses. Mills is the innovator of the Magnetic Susceptibility Imaging (a revolutionary new body scanner), MIRAGE (a cancer therapy program that reduces radiation doses to one millionth of conventional therapy), and GUT (Grand Unified Theory) which he co-authored with his former professor, Dr. John J. Farrell.

The following selection of papers written by these gentlemen have, in general, all been reviewed by *Fusion Facts*:

[1] Dr. R.T. Bush (Cal State Polytech, Pomona), "A Transmission Resonance Model for Cold Fusion." Presented at COLD FUSION - A STATUS REPORT session in conjunction with the ASME Winter Annual Meeting held in San Francisco, CA December 12, 1989. [This paper presents a resonance model for cold fusion and shows how the phenomenon is temperature dependent.]

[2] Robert T. Bush (Cal State Poly Tech.), "Isotopic Mass Shifts in Cathodically-Driven Palladium via Neutron Transfer suggested by a Transmission Resonance Model to explicate enhanced Fusion Phenomena (Hot and Cold) within a Deuterated Matrix," Proceedings of The First Annual Conference on Cold Fusion, March 28-31, 1990, University of Utah Research Park, Salt Lake City, Utah.

[3] Robert T. Bush, (Cal Poly U, Pomona), "Production of Tritium, Neutrons, and Heat Based Upon the Transmission Resonance Model (TRM) for Cold Fusion," *Proceedings of Anomalous Nuclear Effects in Deuterium/Solid Systems,* Brigham Young University, October 22-24, 1990 (in press). [See also review in *Fusion Facts,* Vol 2, No 5, pp 28-29, Nov 1990.]

[4] Robert D. Eagleton & Robert T. Bush (Phys Dept, Calif St Polytechnic U, Pomona, Calif), "Calorimetric Experiments Supporting the Transmission Resonance Model for Cold Fusion," *Fusion Technology*, Vol 20, No 2, pp 239-245, 8 figs, 3 refs, September 1991.

[5] Dr. R.T. Bush (Cal State Polytech, Pomona), "Cold Fusion: The Transmission Resonance Model Fits Data on

Excess Heat, Predicts Optimal Trigger Points, and Suggests Nuclear Reaction Scenarios," *Fusion Technology*, Vol 19, No 2, pp 313-356 84 ref, 25 fig.

[6] Robert T. Bush (Physics Dept, Cal State Polytechnic U.), "A Light Water Excess Heat Reaction Suggests that 'Cold Fusion' is 'Alkali-Hydrogen Fusion'," *Fusion Technology*, accepted for publication planned for May 1992. [Abstract reviewed in *Fusion Facts*, Dec 1991.]

[7] Randell L. Mills, Steven P. Kneizys, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion'," *Fusion Technology*, **Aug 1991**, Vol 20, No 1, pp 65-81, 10 refs.

[8] Randell L. Mills & John J. Farrell, The Grand Unified Theory, Printed by Science Press, Ephrata, PA, c1990 by Mills Technologies, Inc. Available from the authors.

For an insight into Dr. Mills philosophy of science the following quote is important [9]: "I acknowledge that quantum mechanics is strongly entrenched, but even the founding scientists were not convinced of its validity. Quantum mechanics was only begrudgingly accepted over a period of decades, and after decades of development, quantum mechanical theory is plagued with inconsistencies. My theory of the one-electron atom [8] is derived from first principles, predicts four quantum numbers (including spin), and is consistent with experimentation. Quantum mechanics is based on postulates and fails to predict spin. **I do not accept incumbency as a validation of scientific argument.** [Emphasis by Ed.] Each prediction should be tested against experimentation without prejudice of quantum mechanical preconceptions."

[9] R.L. Mills, "Reply to 'Comments on Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion'," *Fusion Technology*, Vol 21, No 1, Jan 1992, p 96.

B. MILLS vs. BUSH: CHEMICAL OR NUCLEAR

On April 26, 1989, Dr. Mills had filed a patent for "Energy/Matter Conversion Methods and Structures." Dr. Mills states [1], "...we scaled it up greater than a factor of a thousand and we have right now a cell running that is a commercial demonstration of this technology. We're pushing right now ... we have a contract we're pursuing that will **give us a one kilowatt -- a one thousand watt home heating unit within four months.** We have the electrochemical power cell -- it is running. It has the capacity of putting out a thousand watts. And we are waiting for the heat exchanger unit to interface with that [power cell] and we will have a prototype of this home heating unit.

Dr. Mills relates the background to his discovery [1]: "I started the theoretical work in 1988, working about a year on the theory, and then I did about 350 experiments looking for tritium and optimizing conditions comparing that to heat I got. Then from about the spring of 1990 through now -- probably a good 500 experiments optimizing these parameters, then through the various scale ups. ... [I've experimented with] cells doing very meticulous computer data acquisition systems that run these cells for long periods of time, turning them off and on in all kinds of conditions and parameters and all kinds of adjustments that optimize the power output, and the power density and trying to determine the economics and cost effectiveness of various configurations, going into 1-watt cells and 10-watt cells and 120 watt cells -- we ran for about a month and a half and then we moved onto this cell with a thousand watt capacity. ... We have a thermal unit and we've been studying that for about a month and a half now and we're ultimately going to produce this one-kilowatt heater for household use."

Further, Dr. Mills comments [1], "I was quite surprised at how rapidly this scaled up and actually it was because we had done all the ground work. We had done about 500 experiments with this very accurate computerized data acquisition system, where we had six of these electrochemical power cells running simultaneously around the clock and we just kept changing in and out all sorts of things and just keeping it going, manning this thing all the time, just keeping it [experimental progress] going as rapidly as possible. And then once we determined all these parameters it's very straightforward to scale it up and I see no limitation to how much power you can get out of this thing" [electrochemical power cell].

The reader will note that in the early experimental work, Dr. Mills was looking for tritium. Inasmuch as tritium cannot be produced by any known chemical reaction, undoubtedly Dr. Mills thought he had discovered a table-top room-temperature nuclear reaction. By April 1989 when he filed his first patent application, Dr. Mills was convinced that he discovered a new type of chemical reaction [2]. In simple, and admittedly inadequate terms, the chemical process is one in which the hydrogen atom is provided with an energy hole so that the single electron collapses from its "ground state" to a lower orbital radius and the resulting energy is absorbed in the available energy hole. Such an energy hole can be provided by certain chemical combinations in an electrolyte. For example, Dr. Mills has had experimental successes using potassium carbonate or rubidium carbonate. However, sodium carbonate does not work (theoretically nor experimentally) so Dr. Mills uses the sodium carbonate

cell as a control. The energy provided by this collapsing hydrogen is about ten times the amount of energy that would be associated with a strong chemical reaction. However, because the energy reaction involves a change in the electron orbit and not in an atomic nucleus, Mills states that the reaction is a new, heretofore, undiscovered chemical reaction. Thus Dr. Mills electrochemical cell would produce energy equivalent to combustion of about 20 gallons of gasoline from each gallon of water [1].

Dr. Bush [3] gives strong credit to Dr. Mills for his achievements but disagrees with his theory. Bush has extended his Transmission Resonance Model (TRM) to encompass Mills work as well as to provide a new explanation for the Pons-Fleischmann electrochemical cold fusion. Bush's new TRM suggests that the observed experimental evidence (cold fusion and Mills effect) are both a result of **nuclear reaction catalysis** [author's terms] in which any one of the three hydrogen isotopes can be induced to combine with an alkali metal nuclide on or near the surface of a nickel cathode (not excluding a possible use of palladium or other metals). The end result is a transmutation of the alkali element into another element. Whether or not such element would be stable can be determined by reference to a table of isotopes. Specifically, Dr. Bush has reported experimental evidence in which a potassium isotope becomes a stable calcium isotope (potassium-39 + proton --> calcium-40.)

How does Bush explain the Pons-Fleischmann results? Simple: the reaction is $^{6}LI + ^{2}D \rightarrow ^{8}Be^{*} \rightarrow 2\ ^{4}He$ + energy. Allthough this reaction was suggested by others, Bush is the first to generalize and predict that a series of nuclear reactions can be produced (under appropriate conditions) by any hydrogen isotope and any alkali metal.

WHO IS RIGHT, MILLS OR BUSH?

Both of these scientists are brilliant and innovative. Dr. Mills is a chemistry major with an M.D. from Harvard Medical School (1986) and several advanced electrical engineering courses from MIT. Dr. Bush is a physicist with a flair for theoretical explanations. Both have been actively involved in electrochemical experiments -- Mills since 1988 and Bush with Eagleton since soon after the Pons-Fleischmann announcements.

Mills claims that he has run a cell using potassium carbonate and light water for hundreds of hours and has not detected calcium. Bush reports that he had detected an increase in calcium in the cells that Bush and Eagleton are running. Both are brilliant scientists. Both are good experimentalists. Both are articulate and both are strongly confident of their position. What is different? They use different nickel cathode configurations. However, both state that the nickel cathode, light water, alkali-carbonate cells are highly reproducible.

It would be surprising to find that Mills, after over 500 experiments, couldn't tell the difference between a chemical and a nuclear reaction. It would be surprising to find that the Bush-Eagleton team would be misled on such an important breakthrough in cold fusion. **It would be surprising and perhaps unique to find that both were right.** However, stranger events have occurred in science. It would be comforting to learn that Mills has discovered a new chemical reaction and that Bush has, finally, explained much of the disconcerting (due to lack of reproducibility) experimental evidence from cold fusion. This author votes for uniqueness and comfort. How do you vote?

REFERENCES

[1] Transcript by Eugene F. Mallove & Jed Rothwell (12/18/91), "Partial Transcript of Radio Broadcast (12/8/91) by Dr. Randell Mills ("Hieronimus and Company" Program), 6 pages. Courtesy of Dr. Eugene Mallove.

[2] Randell L. Mills, Steven P. Kneizys, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte and the Implications for Cold Fusion'," *Fusion Technology*, **Aug 1991**, Vol 20, No 1, pp 65-81, 10 refs.

[3] Robert T. Bush (Physics Dept, Cal State Polytechnic U.), "A Light Water Excess Heat Reaction Suggests that 'Cold Fusion' is 'Alkali-Hydrogen Fusion'," *Fusion Technology*, accepted for publication planned for May 1992. [Abstract reviewed in *Fusion Facts*, Dec 1991.]

C. SAFETY PROCEDURES

SAFETY FOR COLD FUSION EXPERIMENTS
By Avard Fairbanks

[Avard Fairbanks is a senior aerospace engineer with considerable experience in safety procedures. We wish to thank him for this contribution. We extend our deepest sympathy to the family of Dr. Andrew Riley who was killed in a private research laboratory at SRI, International on Thursday, January 2, 1992. Ed.]

Accidents, especially death, encourage workers to re-evaluate their safety procedures. The purpose of this memo is to provide a checklist for use by all cold fusion experimenters. Experimenting with cold fusion can have the following hazards, in addition to possible radiation:

1. The evolved gases from the electrolysis of either light water or heavy water produces hydrogen and oxygen gases which are very explosive. The ignition of these gases is

more likely in contact with metal surfaces and less likely in contact with glass surfaces.

2. Both palladium and platinum are used as catalysts for the combustion of hydrogen and oxygen, especially when finely divided. Both metals are used in recombiners.

3. Palladium and platinum can absorb large amounts of hydrogen (deuterium) especially when aided with electrolysis. This hydrogen will desorb readily from these metals when pressure or electrical potential is removed. During the out-gassing the hydrogen may combine with oxygen at the metal surface and strongly heat the metal which in turn increases the rate of out-gassing. Lowering the electrolyte level so that the metal is exposed, removing the electrical potential, and/or removing a "loaded" electrode from a cell into an oxygen-containing atmosphere are all potentially dangerous.

4. Water-based electrolytes under pressure, especially when superheated, can turn explosively into steam when the pressure is released rapidly, such as happens in boiler explosions.

5. The cold fusion literature cites many examples where "spikes" of excess heat have occurred. If sufficiently strong, such reactions can lead to rapid increases in temperature, rapid increases in pressure in closed cells, and possible runaway nuclear reactions [1]. The result may be all of the above.

It is believed that the following precautions can help prevent disasters:

1. Consider the use of strong isolated water-filled experimental wells in which the cold fusion experiments, especially experiments operating under pressure, are conducted. Note that this procedure is widely used in the testing of underwater gear that uses compressed gases.

2. All experiments should use fume hoods which have viewing areas covered with thick plastic or with flat panes of auto safety glass. Mirror periscopes may be used in sensitive experiments.

3. Exhaust fans should be used on all fume hoods.

4. Energy-absorbing materials should be used to reduce energy of exploded parts. Water, cement blocks, multiple layers of cloth or paper are candidate materials.

5. Fail-safe controls actuated by automatic measuring devices and equipment should be part of experimental design, especially if experiments use pressure vessels. Temperature and pressure are key parameters to be monitored. Controls should be fail safe, for example if power is lost all controls should automatically go to "abort" or "shut-down" mode.

6. Consider the use of burst diaphragms as a backup to pressure relief valves. Ensure that equipment is anchored and vents are directed away from personnel. A burst diaphragm can result in a steam explosion with significant thrust.

7. If practical, cathodes should be flooded with water or oxygen-free inert gases under abort conditions.

8. Dr. Robert T. Bush advises the use of thin-film palladium-coated cathodes. See reference [2]. Thin-film cathodes would not have large volumes of adsorbed hydrogen to release when accidentally exposed to air.

9. Use a minimal amount of electrolyte to reduce volume of possible steam explosion. Provide means for flooding experimental area with water, nitrogen, helium, or other no-oxygen gases.

10. Use face masks or safety goggles, protective vests and gloves whenever they is any possibility of shattering glass.

11. Design cells so that evolved hydrogen and deuterium are kept separate from evolved oxygen until properly ducted to a recombiner. Use over-sized combiners so that a combiner degradation would be less likely to allow explosive gases to escape.

12. Coat glass with plastic to reduce number of glass fragments in case of accidents. John Marshall phoned to suggest that used automobile flat safety-glass (rear windows) can be purchased from junk yards. For low-budget experiments, this is an excellent suggestion.

13. If there are any indications of potential failure, evacuate the laboratory and allow only a properly clothed and protected person re-enter the room if it is necessary to handle the "out-of-limits" cell or system.

14. Add Klaxons, bells, and/or warning lights to be operated by monitoring equipment so that personnel can be warned and observe proper emergency precautions.

REFERENCES

[1] M. Fleischmann, S. Pons, and M. Hawkins, "Electrochemically induced nuclear fusion of deuterium." *J. Electroanal. Chem.*, 261, pp 301-308, and erratum, 263, p187 (1989). In this, their first paper, the authors warn: "We have to report here that under the conditions of the last experiment [last entry, Table 1], even using D_2O alone, a substantial portion of the cathode fused (melting point 1554 C), part of it vaporized, and the cell and

contents and a part of the fume cupboard housing the experiment were destroyed."

[2] Robert T. Bush and Robert D. Eagleton (Physics Dept, Calif. State Polytechnic Univ., Pomona, CA), "A Calorimetric Study of the Excess Heat Effect in Thin Films of Palladium," Presented at Second Annual Conference on Cold Fusion, June 30-July 4, 1991, Como, Italy. [Reported in *Fusion Facts*, July 1991, p 5.]

EDITOR'S COMMENTS

One life is too many to lose in cold fusion experiments. We pray that the unfortunate death of Dr. Andrew Riley will be the catalyst for all of us to diligently augment our safety procedures. Now that kilowatt-sized electrochemical units are nearing commercialization, there will be a great increase in the number of experiments being conducted at elevated pressures and, therefore, increased chances for accidents. We urge our readers to share with us any ideas concerning perceived risks and suitable safety measures. We urge every laboratory to establish active employee-staffed safety committees to identify risks, install safety measures, and train all personnel in accident prevention.

D. NEWS FROM THE U.S.

AROUND THE NATION:
TRAGIC COLD FUSION DEATH
Courtesy of Dr. Faile, Jed Rothwell, et al.

Tim Fitzpatrick & JoAnn Jacobsen-Wells, "Fusion Researcher's Death Shocks His Friends at U [Univ of Utah]," *Salt Lake Tribune,* pg A-1, January 4, 1992.

Selected quotes: "[Dr.] Riley, who worked at the University of Utah from 1987 until last year, was killed instantly when a cold-fusion-type cell exploded in his face at SRI International, a research laboratory in Menlo Park, California. ... 'He was a fantastic guy to work with, a very energetic, dynamic person', said Dr. Sivar Guruswamy, a U. professor [Materials Science] who worked with Dr. Riley." . . . "Charles Fasso, Menlo Park Fire Department, said all cold fusion work at SRI has been suspended pending an investigation. Despite the death and injuries, little damage resulted, Mr. Fasso said."

[Dr. Riley worked at the National Cold Fusion Institute and in the Materials Science Department at the U. of Utah. He was a bright, dedicated young scientist and we extend our sympathy to his loved ones. Ed.]

Brent W. Larkin (Dir. of Editorial Page), "Son of cold fusion," *The Plain Dealer* (Cleveland).

Selected Quotes: "Researchers in England recently coaxed two seconds of power out of ... huge donut shaped lab. The scientists fed in 15 million watts or energy to yield 1.7 million watts ... But the success highlights the ignominy that today dogs cold fusion research. Experiments involving metal rods in jars of water **continue to show intriguing flashes of excess energy and nuclear products like neutrons, tritium, helium, charged particles and even low-energy x-rays.** Yet they remain roundly and unjustifiably ridiculed. U.S. Secretary of Energy James Watkins called cold fusion 'bad science' in May."

[Two days after receiving this editorial, an experiment in McKubre's lab at SRI International blew up showing an unexpected 'flash of excess energy' and killing 33-year-old Dr. Andrew Riley. A combination of a tragic accident and evidence that nuclear reactions can occur in cold fusion. Following are more reports of this tragedy. Ed.]

Staff, "Explosion in Lab Kills Cold-Fusion Scientist," *The New York Times,* Jan 4, 1992, p 6.

"Capt. Jim Lichtenstein of the Menlo Park Fire Department said that the surviving scientists told investigators that an automatic pressure-release valve was not functioning properly on a canister being used in an experiment and that the explosion occurred when one of them [Dr. Andrew Riley] tried to release the pressure manually."

S.L. Wykes (Staff Writer), "Cold fusion-related experiment explodes in Menlo Park lab," *Mercury News* (San Jose), Jan 3, 1992.

Selected quotes: "The experiment had involved five high-pressure cylinders containing volatile gases, including the one that exploded and a second one that bomb squad personnel from the fire district and the San Mateo County Sheriff's Department were able to depressurize. The remaining three cylinders were removed from the lab and temporarily buried at SRI. Those three were to be disposed of today, Menlo Park Fire District officials said." The injured persons were Dr. Michael McKubre, Dr. Stuart Smedley, and Dr. Steven Crouch-Baker.

Staff, "Explosion in Lab Kills Cold-Fusion Scientist," *The New York Times,* Jan 4, 1992, p 6.

"Capt. Jim Lichtenstein of the Menlo Park Fire Department said that the surviving scientists told investigators that an automatic pressure-release valve was not functioning properly on a canister being used in an experiment and that the explosion occurred when one of them [Dr. Andrew Riley] tried to release the pressure manually."

OFFICIAL INVESTIGATION UNDER WAY.

Fusion Facts contacted Dick Clayse in Public Relations at EPRI. He has promised to send us any released information that stems from the ongoing investigation into this tragic accident. Several agencies are involved in the investigation. The investigation may take weeks rather than days was Dick Clayse's opinion. **If you are a researcher in cold fusion, please carefully read the safety article on page 4 which was prepared by an experienced industrial engineer. See also Dr. Bush's article pg 19.**

INDIANA - H SOLUBILITY HYSTERESIS

Y.E. Kim (Dept. Phys., Purdue Univ., Indiana, USA), "Time-delayed apparent excess heat generation in electrolysis fusion experiments," *Mod. Phys. Lett. A,* **1991**, No 6(2), pp 1053-1060, in English.

AUTHOR'S ABSTRACT

In many recent electrolysis fusion experiments, excess heat, T and neutron production were reported as intermittent bursts. These burst phenomena are described in terms of a surface reaction mechanism involving hysteresis of D solubility in Pd as a function of the metal temperature. Excess heat generation is attributable to a hitherto neglected time-delayed chemical process due to the solubility hysteresis of D in Pd. Negative results of no excess heat generation from light-water electrolysis experiments is attributed to the fact that the solubility hysteresis of H occurs at a higher temperature range than does that for D. Apparent excess heat generation is expected to be also observable in blank electrolysis experiments with light water at higher pressures.

MARYLAND - INCREASING D-LOADING

Han S. Uhm, and W.M. Lee (Naval Surface Warfare Center White Oak, Silver Spring), "High Concentration Of Deuterium In Palladium," *Fusion Technology,* **Vol 21**, No 1, pp 75-81, 4 figs, 13 refs.

AUTHORS' ABSTRACT

Based on theoretical calculations, new schemes to increase the deuterium density in palladium over its initial value are presented. A high deuterium concentration in palladium is needed for application to solid-state fusion. The first deuterium enrichment scheme makes use of plasma ion implantation, which consists of a cylindrical palladium rod (target) preloaded with deuterium atoms, coated with diffusion barrier material, and immersed in a deuterium plasma. The palladium rod is connected to a high-power modulator, which provides a series of negative voltage pulses. During these negative pulses, deuterium ions fall on the target, penetrate the diffusion barrier, and are implanted inside the palladium. For reasonable system parameters allowed by current technology, theoretical calculations indicate that the saturation deuterium density after prolonged ion implantation can be several times the palladium atomic number density.

The second deuterium enrichment scheme makes use of temperature gradient effects on the deuterium solubility in palladium. A heat source at temperature T_2 and a heat sink at temperature T_1 (were $T_2 > T_1$) are in contact with two different parts of a palladium sample, which has been presoaked with deuterium atoms and has been coated with diffusion barrier material or has been securely locked in a metal case. The temperature gradient created in the sample from such an arrangement forces the deuterium atoms in the hot region to migrate into the cold region, resulting in higher deuterium density in the cold region.

EDITOR'S COMMENTS

The authors make the following comment in their introductory remarks, "Until now, no conclusive verification of cold fusion has been achieved." It would require the definition of "conclusive verification," but one would expect that Miles work at the Naval Weapons Center in China Lake would qualify as conclusive, at least for the presence of the byproducts of nuclear reactions.

MASSACHUSETTS - FLEISCHMANN AT MIT

Courtesy of Jed Rothwell

David L. Chandler, "British scientist defends cold fusion," *The Boston Globe*, Dec 19, 1991.

Jerry E. Bishop, "Two Chemists Hope to Disclose in '92 Details on Cold Fusion Experiment," December 19, 1991.

Dr. Martin Fleischmann was invited to speak at a MIT seminar. He reported that he and Pons are getting large amounts of excess energy out of their current experiments, which according to other sources are based on the use of palladium-silver alloys. Fleischmann's presentation failed to convince his skeptics at MIT. The *Globe* reported, "The questions were often harsh and heated..." When Fleischmann reported that cold fusion can now be made reproducible and reliable, critics argued that he did not present enough evidence. The *Globe* quoted Louis Smullin (MIT professor of electrical engineering who invited Fleischmann) as saying, "I'm convinced that there's a real phenomenon to be explained." Dr. Phillip Morrison found Fleischmann's talk to be "obfuscating." Richard Petrasso called Fleischmann's talk "very weak" reports the *Globe.* Some critics attack cold fusion because it doesn't conform to known physical theory. Dr. Smullin

is quoted as saying, "when a guy named Prometheus came up with a thing called fire, he had no theoretical basis either." This editor suspects that if MIT were not being funded to the tune of millions of dollars a year for hot fusion, Richard Petrasso and others at MIT would, by now, have become world leaders in the development of cold fusion.

TEXAS A&M - CHEMISTS DIFFER

Courtesy of Marge Hecht

John O'M Bockris (Prof of Chem), "How Physicists and Chemists Differ" *21st Century Science & Technology*, Vol 4, No 4, Winter 1991, pp 65-66.

AUTHOR'S INTRODUCTION

Physicists and chemists think very differently! Most physicists seem much more bound to the dogma of the time than chemists. If one propounds new facts to physicists, they seem to take the attitude that these facts do not fit the current theory (which, mystifyingly, they regard as "the truth"), and that therefore they don't exist ("phony measurement"). There is now a string of solid state phenomena (hot superconductivity, the relation of structure to electronic conduction in organic compounds, and cold fusion) that we do not understand at all. This seems to mean that there is something basic missing in our understanding of phenomena in the solid state. Unfortunately, physicists don't seem to be able to look this in the face and think anew. It seems obvious that the model view of most things evolves and transforms every few decades. But each generation of physicists seems to believe his particular time has final truth.

EDITOR'S COMMENTS

Some of the cold fusion researchers are physicists who have not followed the lead of officers of the American Physical Society in decrying cold fusion. These physicists may not appreciate being tarred with the same brush that Bockris (with tongue in cheek) wields against the Petrasso-like physicists who flail against cold fusion. Bockris relates how, as a graduate student at the Imperial College, he wondered how many of the published theories published before 1900 had survived for 45 years. I have a college physics text that is over 100 years old that states that house flies are beneficial because you can observe them landing on everything and eating dirt. By contrast, this same text has a section on the physics of a "coal-oil" lamp that is very useful to this day (for the rare time when we need to fire up our kerosene lamp during power outages.) Dr. Bockris relates in this article recent successes in producing tritium from cold fusion cells. In addition, an important few paragraphs on "A New Theory for Cold Fusion" has the following important comment: "Now, in Landau and Lifshitz's famous book on physics [Course of Theoretical Physics, Elmsford, N.Y., Pergamon, several editions] there is a chapter on the properties of matter at very high pressures. **These authors calculate the situation of a plasma at 10^{17} bar and find that then the particles lose their charges.** It is at once obvious then, that the difficulty of penetrating the Coulomb barrier is all finished -- fusion would occur at once and yield helium-3 and tritium." Bockris points out that electrochemists have talked for decades of enormous fugacities of hydrogen being locked up in voids inside metals -- higher than 10^{17} bar. In view of Mills' work, Bush's theory, and the Bush-Eagleton experiments (see lead articles this issue), it seems increasingly evident that the cold fusion phenomena is more complex and varied than just a d-d reaction. Fleischmann and Pons were most precise when they suggested in their first cold fusion article, "... energy release is due to an hitherto unknown nuclear process or processes (presumably again due to deuterons)." It is strongly evident that d-d reactions occur in metals and there also appears to be a type of nuclear catalysis involved in cold fusion and in the Mill's effect (chemical catalysis and collapsed hydrogen).

UTAH - MISSING NCFI REPORTS

[An error on the part of the printer of the Volume II Engineering of the Final Report of the NCFI caused the loss of 100 pages of reports. That error has been corrected. The following are summaries of those missing papers. Copies of the NCFI Final Report are available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia, 22161, phone (703) 487-4650. Ed.]

A.M. Riley [deceased], J.D. Seader, D.W. Pershing, D.C. Linton, & S. Shimizu, "Measurement of Absorption of Deuterium in Palladium During Electrolysis of Heavy Water," Investigation of Cold Fusion Phenomena in Deuterated Metals, Final Report, Vol II - Engineering, NCFI, Univ of Utah, June 1991, pp 2-123 to 2-193, 33 Figs, 47 refs, 4 appendices.

AUTHORS' SUMMARY

Ever since the announcement of cold fusion by Pons and Fleischmann, it has been claimed that an atomic loading ratio of D/Pd in the palladium cathode of greater than one is necessary. Because of our success in developing closed cells with internal recombination, it was possible to develop a volumetric technique for making the loading measurement during and without disturbing electrolysis. Application of the techniques is even possible during a calorimetric experiment. At the beginning of an

experiment, the water level in a primary buret connected to the headspace of the cell, is lowered so that it has an empty volume of 50 ml. A vacuum pump is used to evacuate the air from the cell and the buret. After attaining a vacuum of 27 inches of Hg, deuterium gas is admitted to the cell and the buret at atmospheric pressure. This procedure of evacuation followed by filling is repeated a second time to ensure that experiment is then initiated by switching on the flow of electrical current. Initially, most of the deuterium produced by electrolysis at the cathode is absorbed by the palladium cathode. Thus, oxygen produced at the anode reacts with the deuterium gas previously charged to the cell. Therefore, with time the amount of gas in the buret decreases. As the experiment proceeds, this volume decrease in the buret is periodically measured. Immediately prior to the measurement, the pressure in the cell is equilibrated with the atmosphere. During the experiment, atmospheric pressure and the air temperature in the vicinity of the buret are constantly measured. Cell current and voltage are recorded every time a buret volume measurement is made. The system is regularly tested for leaks by moving the second adjustable buret and pressurizing the cell. By initially backfilling the gas space with deuterium gas, a suggestion made by Professor Cheves Walling of the Chemistry Department, an accuracy of better than 5% has been achieved. A total of 62 experiments were run under this procedure covering a wide range of variables, including: Pd-cathode diameter, source, and surface treatment; electrolyte composition (acid and base); and current density (4 to 300 mA/cm^2). Except for 12 experiments, the atomic loading ratio of D/Pd was below 1.0, and typically in the range of 0.65 to 0.85. The steady-state loading ratio did not vary systematically with any of the variables, but the rate of loading did depend upon the current density up to a threshold value. In those cases where the ratio exceed one, other tests at the same or similar conditions gave ratios below one. Thus, it is not known why some ratios attained or exceeded one. Within experimental error, no increase in tritium level above background was observed in any of the loading experiments. [Contrary to work accomplished before the closing of NCFI where tritium was obtained in nearly all of the final experiments. Ed.]

AUTHORS' CONCLUSIONS

1. A simple and reasonably accurate volumetric method has been devised for following the absorption of deuterium by palladium during the electrolysis of heavy-water electrolytes.

2. The initial rate of absorption of deuterium depends upon the current density, up to a threshold value. Below the threshold, the rate of absorption, following an incubation period, is an appreciable percentage of the production rate computed by Faraday's Law. Above the threshold value, the rate of absorption may be controlled by diffusion.

3. The rate of absorption of deuterium also appears to be influenced to some degree by the pH and temperature. The rate is slower in strong-acid electrolyte and at lower temperatures.

4. At current densities above the threshold value, the calculated diffusivity for deuterium in palladium agrees reasonably well with literature values.

5. The saturation or equilibrium atomic loading ratio, D/Pd, is generally in the range of 0.65 to 0.85. The lowest levels occur in strong acid solutions and with annealed electrodes.

6. In most cases, prolonged electrolysis does not cause further increases in loading ratio. However, in a few cases, loading ratios of approximately 1.0 have been achieved, but the reasons for this are obscure.

A.M. Riley [deceased], J.D. Seader, D.W. Pershing, J. Cook, "Heat Conduction Calorimeters for Electrolysis of Heavy Water at Low Power Input," Investigation of Cold Fusion Phenomena in Deuterated Metals, Final Report, Vol II - Engineering, NCFI, Univ of Utah, June 1991, pp 2-194 to 2-223, 7 Figs, 5 refs, 4 tables.

AUTHORS' SUMMARY

The use of heat-conduction calorimeters, which utilize a thermo-electric device to monitor the heat output, was studied for the electrolysis of heavy water with a palladium cathode at relatively low power inputs of less than two watts. Experiments were run with both a paired calorimeter arrangement designed by Hart Scientific and singly operated calorimeters. Calibrations of the calorimeters, made with both light-water electrolysis and internal resistance heaters, were in excellent agreement and were linear and almost independent of temperature over a 20 C temperature range. Results of computerized experiments gave energy balances in the range of 97% to 100%, with somewhat better agreement being obtained with paired cell, which could better account for fluctuations in the environment. In a 31-day experiment, anomalous excess heat of up to 10% was observed during an event that lasted about 100 minutes. However, this event was not accompanied by any excess tritium over background. Heat conduction calorimeters appear to be excellent devices for power input levels up to a few watts.

AUTHORS' CONCLUSIONS

This study demonstrated that it is possible to build relatively inexpensive (approximately $150) heat-

conduction calorimeters that have all the attributes necessary to provide accurate data. These devices have exceptional long-term stability and possess the required accuracy (1 mW) at relatively low levels of heat input (<2Watts). The time response is reasonable with equilibrium being reached in 2 hours. With the exception of one small episode, experiments with these calorimeters failed to show excess heat within the resolution of the calorimeters for run durations of up to 36 days. As with all of the other calorimeters studied to date, the major limitation is lack of control of electrolyte temperature.

A.M. Riley [deceased], J.D. Seader, D.W. Pershing, J. Cook, "Development of an Improved Heat-Flow Calorimeter," Investigation of Cold Fusion Phenomena in Deuterated Metals, Final Report, Vol II - Engineering, NCFI, Univ of Utah, June 1991, pp 2-224 to 2-238, 5 Figs, 3 refs.

AUTHORS' SUMMARY

An improved heat-flow calorimeter for cold fusion studies was developed and calibrated with a resistance heater for two different electrolyte levels. Heat generated in the cell is caused to flow through an inner aluminum sleeve that surrounds the cell, through insulation, and then to an outer aluminum block that is immersed in a water bath. By measuring temperatures in the aluminum sleeve and block with thermistors, the rate of heat flow can be determined as the product of the temperature difference between the sleeve and the block and a cell constant determined by calibration. The cell constant was found to be almost independent of the electrolyte level. Further experiments under heavy-water electrolysis and with internal recombination are needed, together with a computer model, to determine if the dynamic response of the calorimeter is adequate to permit detection of small amounts of anomalous excess heat.

AUTHORS' CONCLUSIONS

The techniques of using a thermal conducting inner aluminum sleeve to integrate the power output of a calorimeter is promising. The cell constant is stable (less than a 2% deviation) over the power range tested (0-6 watts) and extremely linear with power input (variation less than 0.1%). Liquid level in the cell does significantly affect the temperature distribution in the inner aluminum sleeve and, hence, the individually measured cell constants. However, the average cell constant does not change by more than 0.5%. The use of a thermally conducting sleeve is a simple and relatively inexpensive method for producing calorimetric data free of the criticisms leveled at the original type of calorimeters used by Fleischmann et al. (1989, 1990). However, more experiments need to be carried out to assess the magnitude of temperature distributions within the sleeve and the block and to compare these measurements with a computer model. Further experiments should use the Joule heating of an open electrolysis experiments as the heat source. A closed cell should then be tested. This is a different situation than that considered in the study reported here because there would then be two heat sources within the cell, one in the electrolyte and one at the recombination catalyst in the headspace of the cell. In addition, the catalyst is not well thermally coupled to the glass walls of the cell. This should lower the time response and possibly affect the cell constant by creating a fluctuating heat path to the inner sleeve.

A.M. Riley [deceased], J.D. Seader, D.W. Pershing, T. Williams, & D.C. Linton, "Determination of Critical Cold Fusion Parameters by Measuring Excess Tritium From Small-Cell Electrolysis Experiments," Investigation of Cold Fusion Phenomena in Deuterated Metals, Final Report, Vol II - Engineering, NCFI, Univ of Utah, June 1991, pp 2-239 to 2-245, 1 Figs, 2 refs, 1 table.

AUTHORS' SUMMARY

The effect of current density, bath temperature, and palladium cathode surface treatment on the production of tritium was studied for 30 experiments in small electrolytic cells. Each cell contained 20 ml of 0.1 M LiOD. Experiment durations averaged one month. In no experiment was any excess tritium, above background, observed.

AUTHORS' CONCLUSIONS

Until a technique is used to simultaneously measure the degree of loading of deuterium into palladium, it is not possible to assess how successful some of the 30 experiments were in achieving high loading ratios. Such a techniques has recently been developed by Riley et al. (1990) and could be implemented on small cells of the type used in this study. However, it can be concluded that a simple application of known techniques for increasing the activity of the palladium and deuterium uptake are not sufficient to create conditions required for observing the phenomenon of cold fusion.

EDITOR'S COMMENTS

Although many of the engineering reports from NCFI were negative (with respect to the measurement of nuclear byproducts), much good work was accomplished before the funds allocated to engineering were exhausted. Experiments under Dr. Fritz Will's direction just before the closing of the NCFI resulted in tritium being produced and measured in each of several final experiments.

A.M. Riley [deceased], J.D. Seader, & D.W. Pershing, "Search for Neutron Emission from Deuterated Palladium at Low Temperatures," Investigation of Cold Fusion Phenomena in Deuterated Metals, Final Report, Vol II - Engineering, NCFI, Univ of Utah, June 1991, pp 2-246 to 2-250, 7 refs.

AUTHORS' SUMMARY

A preliminary electrolysis experiment at -77 C was conducted for a 12-hour period in an attempt to detect production of neutrons. The electrolyte was 10% D_2SO_4 in absolute ethanol with a deuterated OD group. The cathode was 1-mm diameter palladium wire, 3 cm. long, and the anode was platinum-coated niobium gauze. No neutrons above background were observed using a GeLi detector, which detects gammas from neutron capture by light water.

UTAH & CHINA - PROPOSAL

Zhong Qun Tian (U. of Utah, Nat'l Cold Fusion Inst. and The State Key Laboratory for Physical Chem. of the Solid Surface, Xiamen, People's Republic of China), "A Proposal For A Cold Fusion Study In The Ti/D System," *Fusion Technology,* **Vol 21,** No 1, pp 92-94, 27 refs.

AUTHOR'S ABSTRACT

To enhance the cold fusion process in the Ti/D system, a special experimental procedure is proposed that includes electrolysis in nonaqueous solutions at low temperature (about -70 C), surface pretreatment by depositing nickel film on titanium electrodes, and a unique triggering method based on passing current axially through the electrode wire.

EDITOR'S COMMENTS

In view of the dramatic results in using nickel cathodes (Mills and Bush & Eagleton), this idea for Ni-plated Ti electrode should be tried. The author states that the hydrogen diffusion rate in hydrides of Ti increases by one order of magnitude after the careful pretreatment of the Ti sample. Some experimental work that has been mentioned verbally but has yet to be published has shown some improved effects by current pulsing. The author's suggestion for a "unique triggering method" deserves a trial. Work reported in the Santa Fe "poster session," but not published, showed some unusual results from running current axially through a deuterium-loaded Pd wire. **CAUTION: Use suitable safety precautions for this type of experiment especially if you use large, short current pulses!**

UTAH & ITALY - SUPERRADIANCE

G. Preparata (National Cold Fusion Inst., Salt Lake City, Utah, U. of Milano), "A new look at solid-state fractures, particle emission and cold nuclear fusion," *Nuovo Cimento Soc. Ital. Fis., A,* **1991**, No 104A(8), pp 1259-1263, in English.

AUTHOR'S ABSTRACT

The well-known phenomenon of high-energy particle emissions from newly created fractures in solid materials has a natural explanation in terms of the pondermotive forces exerted by the coherent electromagnetic fields associated with the superradiant motions of the charged plasmas of solids. The possible role of these fields in producing the neutron bursts, that were recently observed concomitantly with crack formation in Ti-deuterides, is briefly discussed.

WASHINGTON D.C. - A PETITION

Staff, "Petition Calls for Congressional Hearings on Cold Fusion," *21st Century Science & Technology*, Vol 4, No 4, Winter 1991, pg 66.

EDITOR'S COMMENTS

The Cold Fusion Research Advocates with address at 2060 Peachtree Industrial Court, Suite 312-F, Chamblee, GA 30341, is led by Jed Rothwell (a computer expert who speaks, writes, and translates Japanese) and Dr. Eugene Mallove (author of Fire From Ice). These two cold fusion advocates are the self-appointed leaders of a petition drive which is successfully gathering several hundred petitions that request the House Committee on Science, Space, and Technology to hold intensive hearings on cold fusion. Their effort has resulted in several media editorials, news reports, and a letter of support from U.S. Congressman Dick Swett (New Hampshire). When the history of cold fusion is written (and probably by Mallove), the record should emphasize the role that self-appointed leaders played on both sides.

WASHINGTON D.C. - DoE REVIEW
From Chem Abstracts, Dec 16, 1991

Ryszard Gajewski (DoE, Washington D.C.), "Nuclear Fusion: hope or illusion?" *Postepy Fiz.* **1991,** vol 42, No 1, pp 85-95, no refs, in Polish.

ABSTRACT

Recent investigations on the problem of obtaining energy by nuclear fusion are reviewed in a rather popular way.

Magnetic and inertial confinement fusion, as well as muon-catalyzed and cold fusion, are discussed.

EDITOR'S COMMENTS

Our readers will remember Gajewski as the DoE official associated with funding Alternative Energy Projects. When he announced that he had money in his budget to use for funding good cold fusion projects, his budget was slashed, he was removed from his position and transferred elsewhere within DoE. It has been suspected that the leaders of the "hot fusionists" were responsible for this curtailment of support for cold fusion.

WASHINGTON, D.C. - FUNDING FUSION

Editorial Staff, "Another Giant Step for Mankind," *21st Century Science & Technology*, Vol 4, No 4, Winter 1991, pg 2.

This editorial properly supports funding for both hot and cold fusion. The following quote illustrates a sincere approach to the development of fusion: "Some scientists today counterpose thermonuclear to cold fusion. This is pure foolishness, the pettiness of seeking advantage in a budget-starved science community. Obviously we should be devoting major resources to the development of both hot and cold fusion (although at present the costs of cold fusion research are minimal in comparison with the thermonuclear budget). From the point of view of basic science, we wish to study fusion plasmas in vacuum conditions (thermonuclear fusion) and fusion processes that take place within metals (cold fusion). As history has shown, studying both simultaneously will immeasurably increase our understanding of each process. . . . It is difficult to predict what the spectrum of uses of fusion -- cold fusion and thermonuclear -- will be in the future, but even today the two programs can gain by being productively integrated. Cold fusion cells produce tritium, and the amount of this production will increase as we gain better control of the whole process. Tritium from cold fusion should cost as little as 1 percent of the cost of tritium produced by present methods. . . . It is also probable that research in cold fusion and any new scientific and engineering discoveries associated with this research may lead to new ways of dealing with fusion engineering problems, such as the materials problems associated with neutron bombardment."

Fusion Facts applauds the above policy. Hot fusion is too expensive to be funded by corporations and is properly being funded by a consortium of nations. The entry level into cold fusion is not more than $100,000 and is expected to be widely funded by business entities. For example, some of the most vigorous cold fusion research in the U.S. has been funded by EPRI, Southern California Edison, and private corporations such as Mills Technologies and several energy companies who are quietly advancing the development of cold fusion.

E. NEWS FROM ABROAD

BULGARIA - PALLADINIZED TANTALUM

Zh. Pancheva, G. Shterev (Bulgaria), "Thermodynamic characteristics of the adsorption of hydrogen on palladinized electrodes." *Nauchni Tr. - Plovdivski Univ.,* **1988**, No 26(5,Khim.), pp 159-174, in Bulgarian.

AUTHORS' ABSTRACT

The thermodynamic characteristics of the adsorption (heat and entropy) allow one to characterize the condition of the adsorbed H on the electrode surface. The total, free, and found energy of the adsorption and entropy were calculated. The effect of the coverage was studied. The value of the entropy for palladinized tantalum is higher than that for the other electrodes.

BULGARIA - Pd PLATING

Zh. Pancheva, G. Shterev (Bulgaria), "Effect of the amount of the deposited palladium on the electrocatalytic activity of palladinized electrode," *Nauchni Tr. - Plovdivski Univ.,* **1988**, No 26(5,Khim.), pp 175-183, in Bulgarian.

AUTHORS' ABSTRACT

The effect of the amount of the deposited Pd on the sorption of H and on the electrocatalytic activity of a palladinized electrode was studied. The electrocatalytic activity, the sorption ability and the relative surface of the palladinized electrode depend on the amount of deposited Pd. The electroredeposition of nitromethane proceeded according to a H mechanism.

BULGARIA - Pd & TEMPERATURE

Zh. Pancheva, G. Shterev (Bulgaria), "Effect of temperature on the adsorption of the hydrogen on palladinized gold electrode," *Nauchni Tr. - Plovdivski Univ.,* **1988**, No 26(5,Khim.), pp 185-191, in Bulgarian.

AUTHORS' ABSTRACT

The affect of temperature upon the adsorption by a palladinized electrode at 25-60° was investigated. The H adsorption by Pd was described by the Frumkin isotherm. The differential heat of adsorption and the bonding energy

of H with the electrode surface were calculated. The values of both quantities depend on the degree of coverage.

BULGARIA - Pd PLATED ON Pt

E. Khorozova, R. Semkova, G. Shterev (Bulgaria), "Effect of the carrier on the electrocatalytic activity of palladium alloys," *Nauchni Tr. - Plovdivski Univ.,* **1988**, No 26(5,Khim.), pp 193-207, in Bulgarian.

AUTHORS' ABSTRACT

A comparative study was made of the adsorptive and catalytic properties of electrolytic Pd alloys with Pb and Cu, deposited on Pt and Ti carriers. The H_2 adsorption and electrooxidation of HCHO, HCOOH, and the cathodic evolution of H in 1N H_2SO_4 were examined. The elements of Pb and Cu, when added to Pd during its deposition on Pt, caused a 3-4 fold increase of its adsorption, while on a Ti carrier the same elements caused a decrease in Pd adsorption. The energy spectrum of H adsorption on the examined electrodes alloyed with Cu and Pb also depends on the carrier.

CHINA - CR-39 TRACK DETECTOR

Courtesy of Professor Xing Zhong Li

Shi C. Wang & Tie S. Kang (Inst of High Energy Physics, Beijing), Ke L. Wang, Shi Y. Dong, Yu Y. Feng, Da W. Mo, & Xing Z. Li (Tsinghua Univ., Beijing), "Identification of the Energetic Charged Particle in Gas-Loading Experiment of 'Cold Fusion' Using CR-39 Plastic Track Detector, Presented at the 2ACCF, June 30-July 4, 1991, Como, Italy, 5 pgs, 2 Figs, 7 refs.

AUTHORS' INTRODUCTION

Since observation of "cold fusion" was claimed in 1989, a great number of experiments have been done for verifying these claims. Most of laboratories were not able to reproduce the observations and among the results of experiments there are obvious inconsistencies. It has been realized that even if the "cold fusion" happened, its signals would be quite weak. Thus for sake of confirming the presence of "cold fusion," it is desirable to use detection techniques which have high collecting power, low background and can stably work for a long time. CR-39 plastic track detector is able to work in passive and time-integrated modes and has a number of unique merits in comparison with electronic detectors. In gas-loading experiments, if a piece of CR-39 film is clamped on the surface of a metal foil of Pd or Ti, charged particles emitted by deuterated metal can be collected by the CR-39 foil with 2 pi solid angle. The information on charge, energy location and direction of the emitted particles can be determined form track parameters.

In the present work, CR-39 plastic films (Track Analysis Systems Inc., Bristol, United Kingdom) have been used for searching for charged particles from deuterized Pd and Ti foils. The effects of high pressure D_2 gas and low temperature on response of CR-39 have been studied and background levels of charged particles from several sources have been estimated. A procedure for identification of nuclear charge of particles has been developed and preliminary result of charge identification was given.

AUTHORS' DISCUSSION

The calibration [of CR-39] using pre- and post-irradiation treatments of gas-loading experiments mimics the actual experimental condition only to some extent. In fact, the effect of environment takes place just during irradiation. So, in order to identify charge Z more accurately, the response of CR-39 should be calibrated using alpha-particle irradiation under the condition of high-pressure D_2 gas and temperature cycle. Since a contamination of alpha particles occurs not very seldom, more experiments are under way to obtain more replicable results.

EDITOR'S COMMENTS

The pictures that were shown at the Como 2ACCF of exposed CR-39 were impressive. This paper essentially cites the details of calibration of the CR-39. This method for recording charged particles is ingenious and inexpensive. We understand that the CR-39 can be sealed and used in electrochemical experiments. We wish to thank Professor Li for sharing this paper with us. This paper should be in the Como Proceedings. See Section H for ordering address.

CHINA - THEORY

Wan-Xiang Zhang (Beijing Institute of Applied Physics and Computational Mathematics), "Possibility of Phase Transitions Inducing Cold Fusion In Palladium/Deuterium Systems," *Fusion Technology,* **Vol 21**, No 1, pp 82-85, 2 tables, 14 refs.

AUTHOR'S ABSTRACT

A tentative theory is presented in which beta-phase PdD_X containing supersaturated deuterium transits into beta-phase PdD_X containing less deuterium and alpha-phase PdD_X. High pressure (approx 10 GPa) deuterium bubbles form at the same time. As the bubbles release energy, cracks are created in the PdD_X crystal, and charge separation of deuterium occurs. Thus would cold fusion

be induced. This proposal supports the fracture mechanism for cold fusion.

[See the review of Bockris' article in *21st Century Science and Technology* on page 8 for another theory idea. Ed.]

CHINA - EARLY CALORIMETRY

Xuwu An, Haike Yan, Buxing Han, Dajun Guo, Deyin Xie, Qihe Zhu, Riheng Hu (Inst. Chem., Acad. Sin., Beijing), "Calorimetric investigation of electrochemically induced nuclear fusion of deuterium," *Thermochim. Acta*, **1991,** No 183, pp 107-115, in English.

AUTHORS' ABSTRACT

Two calorimeters electrically connected in series, one for heavy water and the other for ordinary water for comparison, were used in the investigation of their excess heating rates. The production of *n*, gamma-rays, T and He was not investigated. Cathodes for the 2 calorimeters were made from Pd rods 5.9 mm in diam. and 47 mm in length. They were treated in molten NaOH at 600° for 1 h to activate their surfaces. Pt gauze (0.5 mm eire) anodes were used in both calorimeters. For electrolysis, a current of 0.600 A was first maintained for 96 h and was then increased to 0.800 A, 1.000 A, and 1.300 A for additional periods of 13 h, 16.5 h and 21 h, respectively. A separate measurement with a current of 1.300 A without stirring for 72 h was also made. No evidence of nuclear fusion of *d* was found in this investigation, which was carried out from 14 Apr. to 16 May, 1989.

CHINA - THEORY

Shangxian Jin, Yibing Ding, Baiiu Wu, Yongzhen Biu, Decheng Yao (Grad. Sch., Acad. Sin., Beijing), "The possibilities of electrochemically induced nuclear fusion of deuterium," *Sci. China, Ser A,* **1991**, No 34(6), pp 697-707, in English.

AUTHORS' ABSTRACT

The possible mechanisms of *d-d* fusion during electrolytic infusion of *d* into Pd electrode are studied and a rough estimation of the fusion rate is made. The *d* in the Pd lattice form a strong coupled plasma in which there is a strong screening effect induced by the correlation between ions. This effect increases greatly the nuclear fusion rate. The *d-d* fusion rate in the equilibrium *d* system at normal temperature and atmospheric pressure will never reach the level that can be measured experimentally. The possible results of *d-d* fusion in some experiments may be caused by some nonequilibrium processes in which relatively high energy of *d* and/or high density region are locally produced.

DENMARK - Ni-H CHAINS

Courtesy of Dr. Samuel Faile

L.P. Nielsen, F. Besenbacher, E. Laegsgaard, & I. Stensgaard (Inst. of Physics, U. of Aarhus), "Nucleation and growth of a H-induced reconstruction of Ni(110)," *Physical Review B*, **Vol 44,** No 23, Dec 15, 1991, pp 13156-59, 3 figs, 20 refs.

AUTHORS' ABSTRACT

The dynamics of the hydrogen-induced reconstruction of Ni(110) at room temperature has been studied by scanning tunneling microscopy. The nucleation and growth of the "streaky" (1 x 2) H phase reveal that the reconstruction is very local in nature and evolves as a combined added and missing-row model with -Ni-H- chains growing preferentially along the (110) direction. The hydrogen chemisorption induces a substantial mass transport, which explains why the restructuring is an activated process.

AUTHORS' INTRODUCTION

It is well known that for adsorbates that interact strongly with the substrate, such as oxygen, carbon, and nitrogen, the chemisorption is often accompanied by a restructuring of the surface, which completely changes the bonding at the surface and creates new ordered structures with a significantly altered atomic density in the topmost layers. For an adsorbate such as hydrogen for which the interaction with the metal is so weak that it desorbs around room temperature (RT), the energy cost to break a nearest-neighbor metal bond is higher than the energy gained by chemisorption of hydrogen on a restructured rather than on a virgin metal surface. Thus hydrogen will often either chemisorb in lattice-gas structures on the undistorted metal surface or induce a reconstruction for which the energy cost in breaking the metal bonds is shared in a collective fashion between a sizable fraction of a monolayer of hydrogen adsorbates. The latter scheme often results in reconstructions with no long-range mass transport as for the row-pairing model. However, in the present Rapid Communication it is shown unequivocally that hydrogen adsorption indeed does induce a reconstruction of the Ni(110) surface where metal atoms are moved around over several unit cells. ... There has been a long-standing controversy concerning the structure of this ST(1 x 2) phase, and the driving force for its formation is still under vigorous dispute although the structure has been studied since the early days of modern surface science. We show unequivocally that the reconstruction evolves as a combined added- and missing-row model in which added rows of -Ni-H- atoms grow

preferentially along the (110) direction, i.e., a long-range mass transport is **directly** observed. Furthermore, the results reveal unambiguously that the reconstruction is of a very local nature. ... Based on the present results for the H/Ni chemisorption system, a simple coherent picture evolves which is felt to be of general importance for a detailed understanding of the interaction between chemisorbed atoms and metal surface.

AUTHORS' CONCLUSION

In conclusion, we have unambiguously shown the hydrogen-induced restructuring of the Ni(110) surface into the streaky (1 x 2) phase proceeds by a combined added- and missing-row growth with a substantial long-range mass transport. This directly explains why the transformation to the streaky phase is an activated process.

EDITOR'S COMMENT

This particular Rapid Communication (received 12 August 1991) has been published in the same month (Dec.) that *Fusion Facts* had the privilege of telling its readers about the new Bush findings using light water and a nickel cathode. Dr. Bush's attention was immediately called to this paper because of its possible importance in the understanding of the catalysis of nuclear reactions that may be occuring at the light-water alkali-carbonate electrolyte/Ni surface. It is also interesting to note that the material scientists have been vigorously disputing this topic for many years. The authors relate the use of a fully automated scanning tunneling microscope which can take and store images and then play them back in the form of "motion pictures." We submit that this approach may be applicable to the discovery of what is going on the surface of an active Ni or Pd metal for cold fusion. In addition, it is well known that we do not as yet fully understand either the production of Ni catalysts nor the use of Ni catalysts in the support of chemical reactions. When a light-water cell using a Ni cathode is producing 1,000 watts of energy with a out/in energy ratio of 3 to 5, it is time to recognize that electrochemical power cells are real, that commercialization is pending, and that it is time to augment our research efforts with more inter-disciplinary exchanges. On behalf of its readers, *Fusion Facts* highly compliments Dr. Faile for bringing this type of article to our attention. In addition, our sincere compliments to the authors for their enlightening experimental work.

ITALY - TRITIUM & NEUTRONS

D. Gozzi, Cignini, and M. Tomellini (Universita "La Sapienza" Dipartimento di Chimica, Roma), S. Fullani, F. Garibaldi, F. Ghio, M. Jodice and G.M. Urciuoli (Istituto Superiore di Sanita and Sezione INFN-Sanita Laboratorio di Fisica, Roma), "Neutron and Tritium Evidence In The Electrolytic Reduction Of Deuterium on Palladium Electrodes," *Fusion Technology,* **Vol 21**, No 1, pp 60-74, 20 figs, 19 ref.

AUTHORS' ABSTRACT

A Fleischmann and Pons type experiment was carried out for approx three months in a ten-cell electrochemical system. All the cells were connected in series, and electrolysis was performed in galvanostatic mode at a maximum current of 2.5 A, corresponding on the average to 500 mA/cm^2. In this experiment, all cathodes were made of palladium, and the anodes were made of platinum. In nine cells out of ten, the cathodes were shaped into parallelepipeds ($25 \times 5 \times 5\ mm^3$) by high-vacuum sintering according to a previously reported procedure. The starting material for all these electrodes was palladium sponge powder. The tenth cathode was made of 32 short 0.5 mm diameter palladium wires, gold welded together at one end. A similar concentration of screw dislocations was produced in each wire. Three different groups of sintered cathodes were used in the experiment, corresponding to three different sintering procedures. Nine cells contained 0.2 M LiOD in D_2O as electrolyte. The tenth cell, containing a sintered cathode, was in 0.2 M LiOD in H_2O. Measurements of neutrons, tritium in the solution and in recombined gases, gamma rays, and electrode temperature were carried out. When the current density reached the highest values, a marked increase of the neutron detector count rate with respect to the background level (2 count/h) was observed. The emissions occurred in bursts. This behavior was observed for about 10 days but only when the current density was set at $>320\ mA/cm^2$. In the first part of that period, an excess of tritium with respect to the expected value calculated for the electrolytic enrichment was found in three cells out of nine (one of the cells was in light water). This excess was about twice the amount expected with respect to the enrichment and about four times the initial tritium content in the heavy water (267 decay/min per ml). The other cells, including the one in light water, did not show any excess tritium, the value of which was in good agreement with the calculated value. Some aspects concerning the thermal behavior of the electrodes are also discussed.

AUTHORS' CONCLUSIONS

The results given in this technical note show three significant experimental results, two of which are of nuclear origin. They are as follows:

1. A substantial increase in the neutron count rate was observed after about 60 days of continuous experimentation. The phenomenon showed a discontinuous trend with a burst structure that lasted for

about 10 days, and it seemed to be correlated with the value of the electrolysis current density applied to the ten cells connected in series. There are some indications in our experimental conditions that a threshold does exist at about 320 mA per sq cm. . . .

2. Tritium excess in three cells out of nine (one cell out of ten worked in light water) was found to be equal to about twice the maximum value expected by the electrolytic enrichment and about four times the initial value of the tritium activity. . . . We are confident about these results because we systematically performed more than 350 tritium analyses that were always in agreement, within the experimental error, with the calculated values, and, as other sources of error can be excluded, we believe that a nuclear process was really occurring in those cells.

3. The palladium cathodes that gave tritium production were prepared in a different way from the other cathodes. . . .
Finally, there seems to exist a good internal consistency in our results concerning the tritium production, the tritium/neutron ratio, and the neutron count rate. . . . From the experimental and scientific point of view, we are at a point where a quality improvement of the experimentation is required in order to contribute effectively to the scientific development of this matter. . . . .
In concluding this technical note, we believe that the time is ripe for research on the nuclear process in condensed matter to be considered in the same fashion as other research that does not yet have well-consolidated theories behind it, that does not yield routinely reproducible results, that does not yet have complete acceptance by the scientific community, that will not produce useful energy at least in the near future, and so on, but are financed and studied with the aim to understand.

ITALY - NO NEUTRONS

F. Cannizzaro, G. Greco, M. Raneli, M.C. Spitale, and E. Tomarchio (Universita di Palermo, Dipartimento di Ingegneria Nucleare, Palermo), "Search For Neutrons As Evidence Of Cold Fusion," *Fusion Technology,* **Vol 21**, No 1, pp 86-91, 10 figs, 9 refs.

AUTHORS' ABSTRACT

Investigations performed at the University of Palermo in an attempt to reproduce the "cold fusion" experiment are reported. The search was devoted to detecting neutron emission from palladium electrodes electrolytically charged with deuterium. In no test was neutron emission significantly over the background observed, either in bursts or continuous. Results of a few tests are reported. For the more sensitive test, an upper limit for D(d,n) cold fusion (at 98% confidence level) of $lambda_f < 3.6 \times 10^{-24}$ fusion/s per d-d pair is determined.

EDITOR'S COMMENTS

In their conclusions the authors state that their experiments are in clear disagreement with the observations of Pons and Fleischmann. They did not perform the same experiment. The cathode was Pd sheets. The cell configuration did not follow P-F. The electrolysis was limited to "3- to 25-h time periods." They attempted to measure the least likely event of a P-F cell. Their report has value as a series of experimental methods that did not produce neutrons. We recommend that they contact their fellow scientists in Rome. See report above by Gozzi et al.

JAPAN - MIZUNO'S CELL

Courtesy of Marge Hecht

Fujio Nakano, "The Cold Fusion Cell That Wouldn't Turn Off" and Carol White, "Interview with Tadahiko Mizuno," *21st Century Science & Technology*, Vol 4, No 4, Winter 1991, pp 59-69.

EDITOR'S COMMENTS

These two articles are a combination of a report by Fujio Nakano which was first published in the Japanese mass-circulation magazine, *Bungeishunju*, and an interview by Carol White with Dr. Tadahiko Mizuno who is on the faculty of engineering at Hokkaido University in Japan. Dr. Tadahiko relates that 24 years ago, as a student, he was studying the diffusion of hydrogen into metals. He states, "I even used heavy water, so I may have seen deuterium-deuterium fusion taking place without recognizing it. I did see some strange effects in a deuterium-palladium system that I could not explain at the time." In Carol White's interview with Dr. Tadahiko some details of the earliest replication of the Pons-Fleischmann discovery is reported. In discussing the unexpected event of a cold fusion cell that continued to generate excess heat after the electrolysis was turned off, White reports the following exchange: "Question: You are using a closed cell. Do you think that is responsible for your extraordinary result, since the electrolyte does not simply boil off, as it does in an open cell? [Answer:] Yes, I think the higher pressure [cell not only closed but supports higher pressures] and the higher temperature is advantageous, although I did not plan the experiment in order to get this effect. Actually, I just wanted to conserve my electrolyte. Since our cell is completely closed, we can easily raise the temperature up to 100 degrees and also get higher pressures. We don't have the Fleischmann-Pons problem of boiling off our liquid." Dr.

Tadahiko plans to raise the pressure and work at 300 degrees C in future cold fusion experiments.

JAPAN - GAMMA-RAY EMISSION
From Chem Abstracts, Dec 16, 1991

Shinjiro Wakao, Katsutomo Ozeki, Haruo Sawa (Fac. Sci., Tokai Univ., Hiratsuka), "Gamma-Ray emission from hydrogen-absorbing metal cathodes in deuterium oxide," *J. Adv Sci*, **1990**, Vol 2, No 3, pp 149-52, in Japanese

AUTHORS' ABSTRACT

Since it was reported that the D-D nuclear fusion might be occurring by the electrolysis of D_2O at room temperature, so many scientists are trying to verify the reaction. H-absorbing Pd, Ti, $TiNi_{0.5}$, TiNi, $ZrV_{1.8}Ni_{0.2}$, and $ZrV_{1.5}Ni_{0.5}$, were used as the cathode, and gamma-ray emission was measured continuously by a gamma survey meter accompanying the electrolysis in LiOD/D2 SO_4-D_2O solutions. At the same time, the same experiment was carried out in ordinary H_2O containing LiOH or H_2SO_4 as the reference standard. These cathodes were mainly sintered and the anode was always Pt wire. The electrolysis was carried out by a constant current method till the electrode was saturated by D or H. In the cases of Ti-Ni and Zr-V-Ni system (metals which have larger H-absorbing abilities than Pd), their gamma-ray emissions, i.e., the fusion rates were few times as much as that of Pd. From start to finish of the electrolysis, the fusion rate was not very dependent on the D concentration in the electrode in every case. The fusion rate decreased with the lapse of electrolyzing time. The fusion might be occurring in a D diffuse layer or a reaction zone where the metal phase is transforming to the deuteride phase and micro-cracks are developing because of the lattice expansion.

RUSSIA - FUSION REVIEW
Courtesy of V.A.Tsarev

V.A. Tsarev (P.N. Lebedev Physical Inst., Moscow), "Current Status of Cold Fusion," talk given at the First International Sakharov Conference, May 27-31, 1991, Moscow, 3 pgs, 4 refs (2 are conference reviews by author.)

AUTHOR'S INTRODUCTION

The term "cold fusion" (CF) was known up to March 1989 as the synonym of muon-catalyzed fusion, suggested by A.D. Sakharov more than 40 years ago. Broad use of this term for the last two years is associated with other kind of phenomena: fusion at "ambient room temperature" of nuclei of hydrogen isotopes embedded into crystal lattice.

Nowadays only few remember the unbelievable resonance in the whole world, caused by the first claims of CF from Utah and associated with hopes of a simple and ecologically safe solution to the energy problems confronting humanity.... Later on an overwhelming flow of negative results obtained by different groups and the irreproducibility of almost all the results changed the earlier enthusiasm to skepticism, irritation and disbelief not only in energetics, but also in the reality of the phenomenon itself. Professor Morrison's talk may serve as an example of such extremely negative attitude, which takes a "pathological" form of obscurantism. However it seems hardly reasonable to take a sensible view of the real situation to rely upon speculative philosophical conceptions. This way one can easily attribute many trends of modern society to pathology, since errors and doubts are inevitable in researching new field[s]. It is more wise to do experiments and let the data speak for itself. In particular let us discuss those, presented at the recent Conferences at Provo (USA), and Dubna-Moscow.

AUTHOR'S CONCLUSION

In conclusion, while now there is no reason to hope for energetics [energy useable in the environment], we do have a good reason to believe that CF as some kind of low level anomalous nuclear effects in deuterium/solids exists and is not just mirage, created by artifacts. It turned out to be a much more complicated and difficult problem than had been expected at the beginning and needs very serious and professional study, promising interesting results.

EDITOR'S COMMENTS

Tsarev briefly cites the following main results and problems of CF studies:
1. CF signals have been claimed as follows: a) during D-loading; b) during mechanical failure of D-loaded materials; c) in some chemical reactions; d) in cluster-impact fusion; e) when current is driven through Si/Pd layers.
2. Conditions for CF are not clear.
3. Stochasticity [randomness] is a common feature for all observed CF signals.
4. Neutron emission normally at the Jones' level.
5. Evidence for CF stimulation by pulsed current or other types of "shocks".
6. No understanding, as yet, on the lattice role.
7. Neutron emission has been correlated with acoustic and radio emissions.
8. Many reports of low-level neutron emission from CF exist, however, the case of tritium is controversial. [Due, in large part, to the unwarranted attack by Gary Taubes published in *Science*, June 15, 1990.]
9. The mechanism of cold fusion is not universally recognized.

RUSSIA - SECOND REVIEW ARTICLE

V.A. Tsarev (P.N. Lebedev Physical Inst., Moscow), "Cold Fusion Studies in the USSR," talk given at the Second Annual Cold Fusion Conference, June 29 - July 4, 1991, Como, Italy, 15 manuscript pgs, 71 refs.

AUTHOR'S INTRODUCTION

Offering of a special report dedicated to the Soviet scientists works seems to be quite justified, since they are not well known to the western scientific community. Meanwhile, both quantitatively and qualitatively they bring a noticeable contribution to the world "data bank" on this interesting phenomenon. It is even possible that some of these Soviet works have been "precursors" of the "cold fusion era". However, inadequate integration of our science with the western one, aggravated by scanty telecommunication media development, has slowed down the process of information exchange on CF not only with outer world, but also in our country. It is sufficient to say that the first Soviet National Conference on CF took place only recently in March of this year (March 22-26, 1991, Dubna-Moscow.) Figuratively speaking up to now we have been working behind the scenes and watching the play. Now it is time to raise the curtain.

Figure 1 illustrates the "CF geography" in our country as it was presented at the Dubna Conference. These works are carried out by about 45 Institutes. [In the cities of Arzamas, Cheboksary, Cheliabinsk, Donetsk, Dubna, Erevan, Kaliningrad, Kharkov, Kiev, Krasnoyarsk, Leningrad, Lugansk, Moscow, Novosibirsk, Obninsk, Odessa, Omsk, Podolsk, Rostov, Sverdlovsk, Tbilisi, and Tomsk.] The total number of laboratories which took part in CF experiments is no doubt more. However, many of them stopped or "freezed" their activities after the first unsuccessful attempts and under the pressure of wide-spread skepticism. The CF reputation in our country has suffered greatly from rush and inexact experiments of the initial period, widely boosted with a mass media. The total number of soviet publications on CF certainly exceeds one hundred (more than 80 papers were submitted at the Dubna Conference.) About half of them are devoted to CF experiments, about a quarter are connected with methodical and structural studies, and the rest - with theoretical models.

. . . There are only a few prolonged well equipped experiments with good statistics aimed to a high reproducibility. Calorimetric measurements were not widely spread and developed. At the same time a number of works based on new original ideas and techniques have been done, which might have interesting continuations. . . .

EDITOR'S COMMENTS

Tsarev reports on CF under the following headings: **1. Nuclear mechanofusion; 2. Nuclear chemofusion; 3. Simultaneous direct registration of neutrons and charged products of dd-fusion; 4. Correlation measurements; 5. Cold fusion observations in gas-discharge devices; 6. 14.1 MeV neutrons registration from dt -->^{4}He + n reaction; 7. Neutron burst during PdD self-heating; 8. Surface electron spectra measurements; 9. Gamma quanta emission during electrolysis in the Ti-stream-gas-LiD system; 10. Methods of CF stimulation; 11. Dubna group results; and 12. CF models.**

In his tabular summaries, Tsarev lists 29 positive results in producing neutrons and gammas as compared with 6 negative papers. In charged particle registration there were 4 positive and 3 negative papers. In tritium production there were 7 positive and 3 negative (non-conclusive) papers. There were five papers reporting neutron emission (1.3 to 10 times background) from mechanofusion.

We are indebted to Dr. Tsarev for sending us copies of his papers. This second paper is available in the proceedings of the ACCF2. We hope that the political turmoil in the former USSR will not result in the dissolution of the many high-quality research laboratories and institutes in Russia and its surrounding countries.

RUSSIA - ACOUSTIC EMISSIONS

P.I. Golobnichii, G.I. Merzon, A.D. Filonenko, V.A. Tsarev, A.A. Tsarika (USSR), "Detection of a correlation between nuclear, acoustic and electromagnetic emissions during electrolytic saturation of palladium with deuterium," *Kratk. Soobshch. Fiz.*, **1990,** No 8, pp 26-29, in Russian.

AUTHORS' ABSTRACT

Two events were registered with hard time correlation of the impulses of the nuclear, acoustic, and electromagnetic emissions which confirm the relation between the crack formation and the low-temperature nuclear fusion predicted by the acceleration model.

SPAIN - THEORY

Luis J. Boya (Fac. Cienc., Univ. Zaragoza, Spain), "Possible mechanisms for cold fusion in Deuterated palladium," *An. Fis., Ser. B,* **1990**, No 86 (2), pp 221-3, in English.

AUTHORS' ABSTRACT

Absorbed to saturation in metallic Pd, d does not fuse spontaneously at any sensible rate. Several enhancing mechanisms externally driven, such as alternating currents, thermal hysteresis cycles, *d*-band conduction coupled with Bose statistics, etc. are discussed. More exotic avenues, like He-Moessbauer effect are mentioned.

F. SHORT ARTICLES FROM READERS

EDITOR'S NOTE: Normally, the following article would have been published by a peer-reviewed journal such as *Fusion Technology*. The tragic death of our friend, Dr. Andy Riley prompted Dr. Bush to write and *Fusion Facts* to publish this article to help avoid future accidents.

A Hypothetical "Chemical-Nuclear Chain Reaction" Based Upon the Transmission Resonance Model

By Dr. Robert T. Bush

ABSTRACT: The author's cold fusion model [1,2], the TRM (Transmission Resonance Model) shows that, while most electrolytic cold fusion experiments involve essentially surface, or near surface, reaction, so that only a small amount of the palladium is involved along with only a tiny fraction of the total deuterons in the palladium cathode, it is hypothetically possible, under conditions of high loading and high temperature, to induce a "chemical-nuclear chain reaction" producing a relatively large burst of thermal energy. While this theoretical investigation was prompted by the recent tragic accident at SRI, International in Menlo Park, California, the hypothetical scenario presented here **is not purported to explain that accident.**

In most electrolytic cold fusion experiments there is good reason to believe that the excess heat producing reaction occurs at, or near, the surface of the palladium cathode. This, for example is in agreement with the author's model [1,2] for cold fusion, the TRM. This viewpoint is buttressed by the fit of the TRM, which at the surface involves the activation potential, to excess power data obtained at Cal Poly by the author and his colleague R. Eagleton [4], and also by the recent preliminary cold fusion research in our laboratory involving thin films of palladium [2,3] (as thin as 5 microns in one case) electroplated onto silver and manufactured for us by E. Bubernack and E. Storms of the Los Alamos National Laboratory. Thus, in the typical electrolytic experiment, almost all of the palladium and the d's (deuterons) at interstitial lattice sites within the palladium, are simply not used in any direct way. This use of d's, as it turns out, according to the TRM, will be will be seen to be an important safety feature in these experiments. However, if such an experiment is now pressurized with D_2 gas to produce a high loading fraction of d's to Pd atoms in the cathode, and high temperatures are employed as made possible by the increased boiling point of the heavy water-based electrolyte achieved via that pressurization, there appears, on the basis of the TRM, to be the possibility of a "chemical-nuclear chain reaction" resulting in a relatively large burst of thermal energy. While neutrons would accompany this burst, their number would probably be many orders of magnitude too small to account for the energy release based upon our present empirical knowledge of the branching ratios involved in cold fusion work.

According to the TRM [1,2], two essential conditions for the excess heat reaction to occur are a "lattice" of d's, which is produced by the loading of d's into interstitial sites of the palladium cathode, and then d's incident upon the surface of that lattice of d's. In the typical experiment this fact leads to the surface, or near surface, excess heat reaction (hereafter: surface effect) as previously indicated. However, any change that can turn part of the interior population of d's of the cathode into **itinerant** d's clearly also presents us with the same two essential conditions indicated above. In this case one would now have a **volume effect** for the excess heat in addition to a surface excess heat effect. One or the other may then dominate, or they may be about equal with regard to excess power production. There appears to be empirical evidence suggesting this. Thus, a number of observers have noted that varying the current, e.g., pulsing the current, can make the excess heat effect increase. This can be explained by noting that, if the surface effect is too small to detect, the volume effect induced by varying the current may make the overall excess power contribution of the two effects, volume and surface, large enough to detect. The observer will often indicate that the excess power effect was apparently **triggered** by the current alteration. To understand how the volume excess heat effect (hereafter: volume effect) is induced, recall that the electric field associated with the current provides the predominate pressure to maintain deuteron loading in the cathode. Thus, a lowering of the current will typically lead to a decrease in the loading produced by d's moving out of the cathode, while an increased current increases the ability of the cathode to hold d's and results in the movement of d's into the cathode. With regard to a lowering of the current, the surface effect will typically decrease because of the decreased loading and because the lowered current directly diminishes the flux of incident deuterons upon the surface. However, the increase in the population of itinerant d's, as d's move within the cathode in response to changes in loading, should produce a **volume effect,** which may then predominate in generating excess power. Thus, K. Wolf [5] of Texas A&M noted early on that a palladium cathode in his laboratory had heated up significantly after the current had been turned

off. More recently F. Nakano reported on a cathode that gave remarkable amounts of excess heat for several days after it had been turned off. (The suggestion by J. Waisman [7] that hydrogen diffusion in palladium may take much longer than would be indicated by Fick's law may be applicable here.) And, of course, there is the recent experiment of E. Yamaguchi and T. Nishioka [8] of NTT Basic Research Laboratories of Tokyo in which an explosive burst of heat and neutrons was produced by the "out-transport of deuterons in palladium." A wafer of palladium loaded with deuterons had the d's retained by a thin film of gold on one face and a thin film of magnesium oxide on the opposite face. Approximately an hour after this sandwich had been placed in a vacuum chamber it exploded violently, producing a burst of neutrons and enough thermal energy to fuse the gold with the palladium.

E. Storms [9] of the Los Alamos National Laboratory has mentioned to the author that there could conceivably be a resemblance of the Yamaguchi burst experiment [8] to the tragic accident at SRI, International. This combination prompted the author to explore the hypothetical implications of the TRM for the Yamaguchi experiment and thus, potentially for the SRI accident. In fact, the author had previously considered a volume reaction with itinerant d's when treating the neutron emission component of cold fusion, and especially the results of the experiment by Zelensky [10] (Russia, Harkova Physical Institute) on temperature-dependent neutron emission associated with deuteron thermal desorption from thin films of titanium and palladium that had been ion-implanted with deuterons. This consideration led the author to treat the interior of a loaded palladium (titanium) crystal as a superposition of "diffraction gratings". Then for a given fractional loading (or stoichiometry, which is actually a technically correct term only in the case of titanium), the problem is partially statistical in that one established the different average chain length, and thus weighting factors for the different gratings. Thus, considering a one-dimensional chain of interstitial sites, the possible gratings are as follows: those for which every d has a nearest neighbor in the one-dimensional chain; those with every other interstitial site empty; those with only every third site occupied by a d; etc., etc. Of course, as the loading fraction increases the gratings consisting of d's with nearest neighbors predominate. Prior to the author's poster session presentation [11] at the Como meeting showing an excellent fit of the TRM to Zelensky's data, and prior to my giving computer printouts to several experimentalists doing neutron burst work, the author obtained permission from the editor, G. Miley [12], to send a partially-completed theoretical paper, "The Deuterated Metal Lattice as a Superposition of Diffraction Gratings: A Partial Explanation of Neutron Emission in Cold Fusion" [13], to *Fusion Technology* containing the fit of the TRM to the Zelensky data as well as the algorithms employed to predict the temperature-dependence of the neutron emission lines for titanium (palladium) along with their derivation and explanation. Thus, for example, the approximate centers of the principal temperature-dependent neutron emission lines for titanium and palladium, from roughly about room temperature down to about absolute zero are as follows (a temperature in bold implies a primary emission line --largest reaction strength -- and other temperatures indicates a line of secondary reaction strength:

Temperatures for deuterated titanium: -3C, **-30C,** -56C, -104C, **-120C,** -146C, -183C, **-198C,** -213C, -236C, **-246C,** -255C, **-270C.**

Temperatures for deuterated palladium: 6C, -50C, **-78C**, -105C, -153C, **-173C,** -193C, -225C, **-238C,** -249C, **-269C.**

The point to be made here is that the volume reaction for neutron production would be accompanied by other reactions associated with, for example, and very importantly, excess heat. As already mentioned, the excess heat would be expected to be many orders of magnitude too large to be correlated with the neutron production. We now proceed to demonstrate a hypothetical "chemical-nuclear chain reaction" associated with the stoichiometric and temperature-dependent parts of the relative excess power in the TRM.

Figure 1 shows part of the temperature-dependent emission lines with their relative heights shown for the respective stoichiometries S= 0.96, 0.94, 0.92, 0.90, and 0.80. The bases give respective widths of the transmission resonance **windows** [1,2], which the approximate relative height of a window is given **by the height of the Maxwell-Boltzmann energy distribution employed for the itinerant d's for the temperature (energy) at the center of the transmission resonance line times a factor for the relative heights of that line based upon the stoichiometry as shown in Figure 1.** (See the figure, Col 1 page 21.)

Figure 2 (See Col 2 page 21) shows the corresponding hypothetical **temperature-dependent relative total excess heat production rates** (arbitrary units) **versus temperature from about room temperature to about the melting point of palladium** for the stoichiometries of 0.80, 0.92, 0.94, and 0.96, where all other factors are assumed to be the same. **Note the rapid rise of the relative reaction rate curve with small changes in S.** (Similar curves could be worked out for cases of S greater than 1.00).

[Text is continued after Figure 1 on the next page and then underneath Figure 2, column 2 on the next page.]

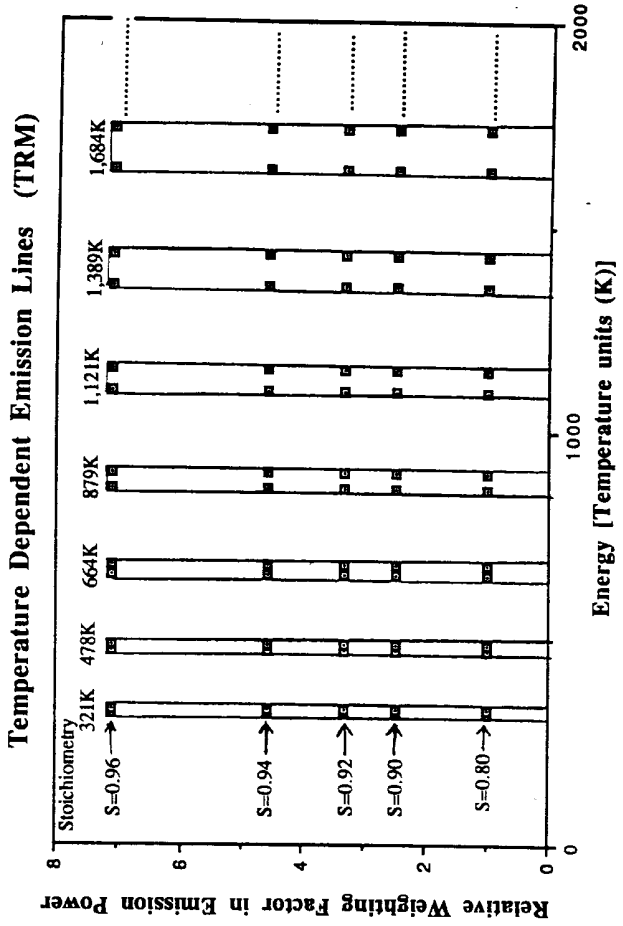


Figure 1: Temperature-dependent emission lines, indicated by the columns, for deuterated palladium based upon the TRM.

Temperatures at the top indicate the energies (in temperature units) of the centers of the six lines from 321K to 1,684K. Note that line widths increase as the energy increases, and that the relative heights, which provide a relative weighting factor for the emission power, increase with the stoichiometry, S, but are independent of energy (temperature units). **Thus, the line centered on an energy of 1,121K for S=0.96 has a width about twice that of the line centered on 321K for S=0.80 and has a relative height about seven times that of the latter.**

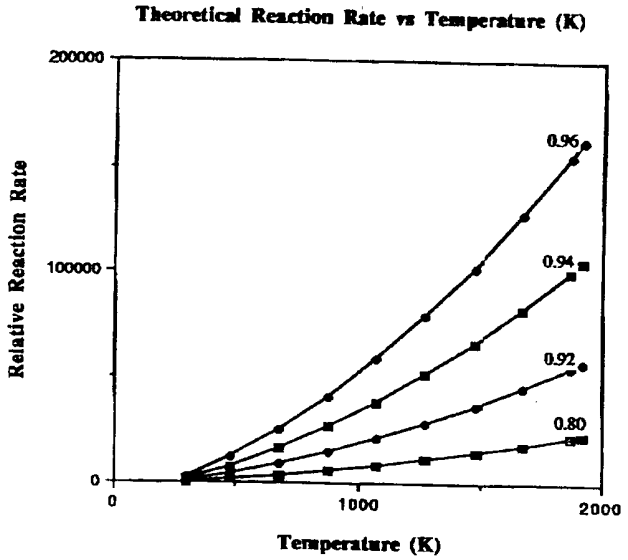


Figure 2. Relative reaction rate as a function of cathode temperature for four difference stoichiometries based upon the TRM.

Thus, for example, according to the TRM the reaction rate (total excess power production) in the cathode would be about 30 times as great for the case in which the temperature is 1,850K and S=0.96 as for the case of 1,000K, S=0.80.

Consider a highly-loaded cathode in operation with a significantly elevated electrolyte temperature. If now the electric field maintaining the high stoichiometry of the cathode were cut off, or significantly reduced, the resulting rate of excess heat production in the cathode volume associated with the suddenly-increased population of itinerant d's reacting with the various diffraction gratings of d's in interstitial sites could be large enough to generate a relatively large pulse of thermal energy. The decrease in electric field could be triggered by the venting of the deuterium gas: If the D_2 gas pressure were reduced to the point that rapid boiling of the electrolyte occurred, the depth of electrolyte would rapidly decrease uncovering the cathode. The corresponding decrease in the electric field would result in the creation of a significant number of itinerant d's throughout the cathode volume setting the stage for the formation of a thermal energy pulse. The D_2 gas would not ignite, since there would be no oxygen in the pressurized vessel for it to undergo combustion with. However, transfer of thermal energy to the steam and to this gas could cause the violent expansion that would test the mechanical strength of the containing vessel.

This type of reaction might be characterized as a "chemical-nuclear chain reaction" since the decrease in the electric field caused by the decrease in the electrolyte level would cause the rapid buildup of itinerant d's as the latter are boosted out of interstitial sites. With the proportional increase in the number of cold fusion reactions further increasing the temperature and the resulting increasing rate of decrease in the electrolyte level, the process might be accelerated, etc. From the time at which the electrolyte level began to decrease, due to vaporization of electrolyte, it is estimated that the buildup of a critical overpressure in a pressurized canister of ten centimeter radius might have required about a millisecond. Again, however, it must be reiterated that this scenario is strictly

hypothetical and does not necessarily provide an explanation for the tragic SRI accident.

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[9] E. Storms, Los Alamos National Laboratory, Private communications, January 1992.

[10] V.F. Zelensky et al., Kharkov Inst. report KhFTI-89-61, 1989. V.F. Zelenskii, V.F. Rybalko, A.N. Morozov, G.D. Tolstolutskaya, V.G. Kulish, S.V. Pistryak and I.S. Martynov, "Experiments on Cold Nuclear Fusion in Palladium and Titanium Saturated with Deuterium by Ion Implantation," *Vopr. At. Nauki Tekh., Ser.: Fiz. Rad. Pov. Rat. Mat.* (USSR), 1990, pp 65-77 (in Russian). [This work cited in *Fusion Facts* June 1991, pg 13.]

[11] R. Bush, "The Transmission Resonance Model (TRM) for Cold Fusion Updated: Explication of Neutron Emission," poster presented at the Second Annual Cold Fusion Conference, Como, Italy, July, 1991.

[12] G. Miley, Editor, *Fusion Technology*, Private communication, Spring 1991.

[13] R. Bush, "A Deuterated Metal Lattice as a Superposition of Diffraction Gratings: A Partial Explanation for Neutron Emission in Cold Fusion." Paper in progress; to be submitted to *Fusion Technology*.

ACKNOWLEDGMENTS: I am happy to acknowledge helpful discussions with E. Storms of the Los Alamos National Laboratory. My colleague at Cal Poly, R. Eagleton, is thanked for computing work, and for serving as a sounding board for my ideas. Hal Fox, Editor, *Fusion Facts*, is gratefully acknowledged for his help with several references. E. Kidd, a Cal Poly computer science undergraduate major is thanked for a significant amount of computer work that helped with the figures. Finally, the financial support of Southern California Edison, Inc. of Rosemead, California has been deeply appreciated. Special thanks go to N.J. Kertamus of Southern California Edison for his interest and support of the Cal Poly, Pomona cold fusion project.

G. LETTERS TO THE EDITOR

NEW ENGLAND JOURNAL OF MEDICINE IS MISINFORMED

Note from Marge Hecht, *21st Century Science and Technology*

Marge Hecht cites the following misinformation from the Nov 7, 1991 *New England J. of Medicine,* pg 1372: [Article justifies the Ingelfinger rule where Journal publishes only that which has not been submitted or reported elsewhere and cites abuses of science by press conference including the announcement of a drug for treating HIV.] "...The hopes of patients with HIV infection were raised, as was the stock in ICN Pharmaceuticals. Subsequently the Food and Drug Administration found the claim to be unwarranted. **Science by press conference is not limited to the field of medicine, of course, Pons and Fleischmann engaged in a spectacular example when they announced that they had achieved cold fusion.** Their institution, the University of Utah, was promptly voted substantial funds by the state legislature to further the research. Once again, the work was not published. It is not clear whether the announcements about cyclosporine

and ribavirin shortened lives, but they did raise false hopes and contribute to indiscriminate cynicism about the validity of medical research. There is an inevitable tension, then, between the orderly process of science and the public's right to know, between quality and speed, between doing it right and doing it fast."

[**Note the misinformation:** Pons and Fleischmann submitted their patent applications and their technical paper to peer-reviewed journals prior to public announcement. Pons and Fleischmann did not call the press conference. The press was called by University officials because of numerous calls they were getting from many people with copies of the paper that had been submitted for peer review. **The news of the evidence of cold fusion was too dramatic to be contained by the protocols of the peer review process.** The reported production of tritium and excess heat and the reported neutron production were replicated in at least twelve laboratories within thirty days. The current count of replication is more than 120 laboratories in more than 20 countries. Peer-reviewed publications of failures are still being **cited to the gullible** as proof of failure of Pons and Fleischmann and as proof that cold fusion is not real. What is leading to public cynicism is the unquestioning acceptance, even by the professional media (*Science, Nature, Encyclopaedia Britannica, Nova, et al.)* of emotional attacks on the credibility of two brilliant scientists and/or their work. *Fusion Facts* is sorry to find that the staff of *The New England Journal of Medicine* would become another unwitting party to the unprofessional and emotional attack on cold fusion. The public has the right to know the facts and the right to have the facts reported **right and fast. Slowness is not righteousness, neither is misinformation. Lives are being lost by unnecessary energy-related pollution. Stick to medicine NEJM, you are not competent in cold fusion.** Hal Fox, Editor-in-Chief.]

NOTE ON H_2O DILUTION
By Dr. Samuel P. Faile

Referring to "*Fusion Technology*, "Review of Experimental Observations About the Cold Fusion Effect," by Edmund Storms, pp 433-477, Vol 20, No 4, December 1991 (an impressive review with 359 references). This review covered published information. In a survey of heat effects Dr. Storms noticed that the researchers obtaining positive excess heat results tended to have more accurate calorimeters than the ones reporting negative results. [Contrary to statements by Petrasso who makes claims of much better equipment on the part of many who reported negative results. Ed.] On page 441 is mentioned the effect of light water replacement on excess heat. The substitution of H_2O for D_2O took from 20 to over 100 hours to cause the disappearance of the excess heat. An important clue to the cold fusion puzzle may have been revealed. The cold fusion reaction is thought to occur mainly at the surface. If the cold fusion reaction is dependent on deuterium, why does it take so long for the excess heat production to stop? It would appears that the use of H_2O would quickly cause the surface layer to be loaded with hydrogen rather than deuterium. Perhaps a resonating quantum potential wave is set up that is stimulated by the collective delocalized deuteron wave functions. The resonating quantum potential wave would take time to form and be pinned to the palladium lattice or metal surface."

[Many articles and technical notes have been written speculating on how the d-d reaction can take place, be started, or continue. Experimental evidence has been cited ranging from short bursts of nuclear byproducts and/or heat to the long-term production of heat. Two groups in Oak Ridge got contrary results in light water dilution of their working experiments showing both quick and slow quenching of heat-producing cells. New experimental evidence is in the process of being published that shows promising results in the use of light water and nickel electrodes. *Fusion Facts* looks forward to sharing these reports of peer-review articles on these experiments. We are especially interested in reports that support the "ease of replication" found in the light water/nickel cells. For example, we have great respect for the scientific ability of Dr. V. Noninski and Dr. James McBreen, both of whom have replicated the light water/nickel cathode experiments. Dr. Faile has been one of our best suppliers of information and speculation in his continued search for understanding of cold fusion. We thank Dr. Faile for his continued contributions. Ed.]

LETTER FROM BEIJING, CHINA
From Professor of Physics, Xing Zhong Li

After some kind personal comments, Prof. Li writes: "During my six-year stay in the US (1979-1985) I was impressed by the unselfish dedication of American friends. Science cannot develop without such dedication. In the last letter, I enclosed a copy of my review talk, "The Chinese Effort in Understanding the 'Cold Fusion' Phenomena"... Through that report you see what I have been working on and thinking about (three anomalies). ... [As covered in the enclosed] copy of "Identification of the Energetic Charged Particles in Gas-Loading Experiment of 'Cold Fusion' Using CR-39 Plastic Track Detector". This paper is supposed to be published in the Proceedings of II ACCF. If you think that these papers are helpful I may send you more along this line.

"I have been engaged in the theory of the Plasma Physics and Controlled Fusion for more than thirty years. I am attempting to understand what happened in those three

anomalies while I am pushing forward the necessary experiments within the limited funds [available]. We do have some "models" or "theories" to explain these experiments (the Precursors and the Energetic Charged Particles). I would like to send the short article about our work when it is available. Currently, none of my colleagues are working in or theorizing about Zero-Point Energy. Perhaps they will in the future."

[Comments: We are most pleased to hear from our scientist friends abroad and we will be most pleased to receive copies of any papers they can send to us. We do welcome short papers on current cold fusion topics. Thank you Professor Li for your letter and the copy of your recent paper. See our review in this issue: **China - CR-39 Track Detector.** Ed.]

H. CONFERENCES, PAPERS & MISC.

PROCEEDINGS NOW AVAILABLE

The Proceedings of **II ANNUAL CONFERENCE ON COLD FUSION**, Como, Italy, June 29 to July 4, 1991 are now available. For information on ordering, please write to: SIF, Via L. degli Ondalo 2, 40123 Bologna, Italy.

LETTER FROM JAPAN
From Professor Hideo Ikegami

ANNOUNCING: THE 3rd INTERNATIONAL CONFERENCE OF COLD FUSION (ACCF3)

Date: October 21 (Wed) - October 25 (Sun), 1992
Place: Nagoya Congress Center, Nagoya, Japan

The conference will cover the broadest topics relevant to the cold fusion phenomena in the broadest research fields including nuclear physics, electrochemistry, and solid-state physics.

The tentative dead lines are:
Preliminary Registration: 15 March 1992
One-Page Abstract: 15 June 1992
Final Registration: 1 September 1992

The succeeding announcements will be mailed solely to those who return the preliminary registration form by 15 March 1992.

The final registration form and a hotel reservation card will be enclosed with the 2nd and 3rd Announcements which will be sent in April and July 1992, respectively.

For further information contact the Conference Chairman:
Professor Hideo Ikegami
National Institute for Fusion Science
Nagoya, Japan 464-01
Phone: 052-781-5134 (office)
Fax: 052-781-9564
E-Mail: ikegami@nifs.ac.jp

Fusion Facts will continue to publish the latest information about this conference to keep you informed. Prof. Ikegami states, "The next cold fusion conference in Japan will be a crucial and exciting one."

NEW FROM *FUSION FACTS - Fusion Briefings*

New from the Fusion Information Center is *Fusion Briefings*, a 3.5 page newsletter, that is a monthly digest of cold fusion developments. Written with the lay person in mind, it is an overview of what is happening in the areas of research, business, patents, and the companies involved with cold fusion. Designed for the manager who needs to be aware of cold fusion development, but does not require all of the technical details, *Fusion Briefings* lets him track the developments that will have the most impact on his business.

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If you know someone who is interested in learning about cold fusion, "Fusion Concepts" may be the best way to teach over eighty concepts associated with cold fusion. If cathode and anode are meaningless and confusing as you read about cold fusion developments, then "Fusion Concepts" can help clarify what the difference is and how they are used. "Fusion Concepts" is interactive courseware that takes an individual through the physics and chemistry background that makes up cold fusion, but controls the learning by allowing the student to progress only after the student demonstrates that he understands each concept. "**Fusion Concepts**" is a two-diskette IBM-compatible software package for $95.00, and comes on either 3.5" or 5.25" diskettes. The second diskette includes **INFOFIND**, a search and retrieval program that allows the user to enter any non-trivial word(s) and be positioned in the text material at any selected line where that word(s) occurs.

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***Fusion Facts* DOES ACCEPT SHORT ARTICLES**

The goal of *Fusion Facts* is to present the latest information on enhanced energy devices in **the shortest possible time**. Therefore, we use only our local staff, correspondents, and scientist friends in making acceptance decisions on submitted articles.

We are especially interested in any new discoveries that improve the replication of cold fusion electrochemical cells or of other devices that provide excess energy. We are also interested in simply-stated summaries of your theories or models, especially as they pertain to improvements of devices that produce excess energy.

Brief **Letters to the Editor** are also welcome. Topics of interest include latest business developments related to cold fusion, patent information, and your constructive criticism of any cold fusion concepts. We especially welcome news of any **enhanced energy devices** that have been reduced to practice.

Remember to keep your written material simple but precise. A large fraction of our subscribers do not have English as their primary language.

Send your contributions to Hal Fox at:

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