FUSION facts

A Monthly Newsletter Providing Factual Reports On Cold Fusion Developments

ISSN 1051-8738 • University of Utah Research Park •

ISSN 1051-8738

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

VOLUME 8 NUMBER 4 **OCTOBER 1996**

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NOW AVAILABLE!

Journal of New Energy

Volume 1, number 3, Fall 1996 issue presents the Proceedings of the Second Low-Energy Nuclear Reactions Conference, held Sept. 13-14, 1996, College Station, TX.

This issue of the *Journal of New Energy* may be the most important collection of energy papers yet published! **This conference has already engendered new patent applications! Don't miss this issue!** The price for this quarterly journal is $150 per year with each issue airmailed (single copies $45). The journal is abstracted by *Chemical Abstracts*, *Metals Abstracts*, and *Engineering Information*. **Order now!**

A. THE BEST CONFERENCE FOR COLD FUSION

Hal Fox, Editor

After having read the transcripts of the ICCF-6 and having served as editor to the *Journal of New Energy*, volume 1, number 3, Proceedings of the Second Conference on Low Energy Nuclear Reactions, it is the judgement of this editor that the best and most information conference on cold fusion was the conference on Low Energy Nuclear Reactions, September 13-14, 1996. This conference was held at College Station, Texas and hosted by Professors George Miley and John O'Malley Bockris.

The most important papers of this Low Energy Nuclear Reaction conference, in the judgement of this editor were the following:

"Nuclear Reaction in Palladium-Hydrogen Systems," by Miley and Patterson.
"The Reaction Products Induced by Isotopic Changes of Electrolysis," by Mizuno, Ohmori, and Enyo.
"Excess Heat and Unexpected Elements from Electrolysis of Acidified Heavy Water with Titanium Cathodes," by Dash and Kopecek.
"Electronuclear Transmutation: Low-Energy Nuclear Reactions in an Electrolytic Cell," by Bass, Neal, Gleeson, and Fox.
"Isotopic Distributions of Heavy Metal Elements Produced During the Light Water Electrolysis on Gold Electrode," by Ohmori, Mizuno, and Enyo.
"Observations on the Role of Charge Clusters in Nuclear Cluster Reactions," by Shoulders and Shoulders.
and "Plasma-Injected Transmutation," by Fox, Bass, and Jin. This paper serves as a conference summary.

The totality of the papers at this Low-Energy Nuclear

Reaction conference has started an intense new investigation into new methods for creating and controlling low energy nuclear reactions.

B. 6TH INTERNATIONAL CONFERENCE ON COLD FUSION

ABSTRACTS taken from the 6th International Conference on Cold Fusion held October 13-18, 1996, in Hokkaido, Japan, *Program & Abstracts*.

JAPAN

Y. Arata and Y.C. Zhang (Arata Hall of Osaka Univ., Japan), "Achievement of Solid-State Plasma Fusion (`Cold-Fusion')," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program and Abstracts*, pg 27.

AUTHORS' ABSTRACT

When the deuterium nuclear fusion takes place continuously in solid, the tremendously released energy will heat the solid drastically and the product by reaction will be spontaneously emitted from and/or confined as the "frozen state" in the host-solid. In other words, there are two kinds of reaction, i.e., the energy release and product formation. These reactions should increase proportionally with increase in number of fusion reaction for a long period. As a result, tremendous amounts of reaction product, i.e., Helium, should be accumulated as the frozen state in the host solid which generated huge excess energy in ordinary temperature.

Therefore, when the Pd host-solid (Pd-black) was heated to high temperature ($\geq$ 1300 [K]) in vacuum, a large amount of Helium released from solid was detected by "QMS" (Quadruple mass spectroscopy). Namely, in the present experiment, the solid-state plasma fusion ("Cold Fusion") was verified by detection of tremendous Helium product as well as huge excess energy.

Naoto Asami, Toshio Senjuh, Hiroshi Kamimura, Masao Sumi, Toshinori Shigemitsu (Nuclear Fuel Industries, Ltd.), Kenya Mori (Tanaka Kikinzoku Kougyou Ltd.), Hisashi Watanabe (NEDO), and Kazuald Matsui (R&D Center for New Hydrogen Energy, Inst. of Applied Energy, Japan), "Material Behavior of Highly Deuterium Loaded Palladium by Electrolysis," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 31.

AUTHORS' ABSTRACT

Studies on the several kinds of Pd cathodes have been conducted using electrochemical cells with $LiOD/D_2O$ system to seek for and clarify the high deuterium loading conditions.

Comparative observations of microstructure and analysis of surface impurities have been carried out for the pre-and post-electrolysis Pd specimens with various preelectrolysis treatment and process.

Single crystals of Pd absorbed the deuterium slowly, however reached the highest loading ratio, D/Pd = 0.89. Many fine slip band structures were observed on the surface, and **several micro-cracks existed in the crystalline of post electrolysis specimens.**

High purity (>99.995%) polycrystals of Pd with surface purification treatment such as annealing at 850 ~ 1150° C in high vacuum, also showed high loading characteristics. Thermal etching effects were remarkably observed on the surface of annealed specimens at higher temperature with high vacuum conditions. Surface micro-cracks along the grain boundary were investigated. This sort of cracks seem to be generated in deloading process of deuterium. Blistering on the electrode surface occurred in some cases. Deuterium blistering seems to have occurred in case of existence of closed pore or plane shaped defect near the surface of Pd electrode during electrolysis.

Surface impurities analysis by AES, SIMS and EPMA showed that the Li atoms penetrate into the Pd cathode about several 100 ~ 1000 from the surface. Depositions of another impurity atoms were also analyzed.

From these observations and analysis of various processed and treated Pd specimens, the material characteristics of Pd cathode achieving high loading ratio are discussed. And in- situ observation of crystallographical structural change by X-ray diffraction method and surface microstructure by optical micrograph during electrolysis have been developed. Preliminary results of these in-situ investigations will be also presented.

These studies have been conducted under the consignment of New Energy and Industrial Technology Development Organization (NEDO).

H. Fukuoka, T. Ikegawa, F.A. Takahashi (Dept. of Nuclear Eng., Osaka Univ., Japan), "Measurements of Excess Heat and Nuclear Products in Pd-D_2O System Using Twin Open Type Electrolysis Cells," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 61.

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AUTHORS' ABSTRACT

In order to observe the correlation between excess heat and nuclear products, the on-line measurements of excess heat, neutron and X-ray emission during the electrolysis of 0.2M LiOD heavy water electrolyte using Pd cathode have been continued after our first report at ICCF5. The experimental system is twin type for both of electrolysis cells and radiation detections and two type experiments are able to be practiced at the same time, for example heavy water electrolysis and light water electrolysis using Pd cathodes for both cells. The advantage of this twin experimental system is that simultaneous events happening in both cells can be rejected as the noise. The electrolysis cells are open type and excess heat is determined by CA thermocouple outputs by the cell temperature calibration method. NE213 neutron detectors are placed in front of the cells. Neutron signals are separated from γ-ray signals by two dimensional analysis of rise time and pulse height. X-rays are detected by CdTe X-ray detectors. The purpose is the detection of characteristic X-rays (21 ~ 23 keV) that will be generated in the slowing down process of emitted charged particles with several MeV kinetic energy in Pd metal. For the X-ray detection, rise time discrimination is adopted to separate signals from noise components. These measurements are always monitored by PCs. At most of experiments, the electrolysis current was changed periodically from LOW (1.0 or 1.3A) to HIGH (3.8 or 4.0A) or the reverse in every 3 or 6 hours in order to give dynamic change of deuterium accumulation in Pd metal. Most experiments have been conducted for about one month. In experiments, we use various Pd plate cathodes (25 x 25 x 1 mm) with different treatments (cold worked or annealed).

After two cases of excess heat observed in the previous work, no excess heat has been observed out of six experiments. However, in one case, during the electrolysis using 1.0A constant electrolysis current and annealed Pd cathode, neutrons increased as a burst and X-ray increased simultaneously. In this case, the simultaneous emission was observed only for heavy water electrolysis cell and no change was observed for the light water electrolysis cell. In another case, the counts of soft X-ray in the region of 5 ~ 15 keV increased for heavy water electrolysis cells, but the energy didn't agree with the Pd characteristic X-rays.

To investigate these soft X-rays more in detail, X-ray spectroscopy with high resolution Si-SSDs cooled with Peltier devices is under way.

Shigeru Isagawa, Yukio Kanda and Takenori Suzuki (Natl. Lab. for High Energy Physics, Japan), "Mass Spectroscopic Search for Helium in Effluent Gas and Palladium Cathodes of D_2O Electrolysis Cells Involving Excess Power," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program and Abstracts*, pg 26.

AUTHORS' ABSTRACT

The low intensity of neutron and the small enrichment of tritium in cold fusion experiments have prompted proposals of nuclear processes that yield only heat and helium as products. Determination of the presence or absence of ^{4}He as a nuclear product became very essential.

A mass spectroscopy system was built to meet this special demand. Effluent gas during electrolysis as well as electrically charged solid palladium samples can be analyzed with high sensitivity and sufficiently good resolving power.

Until now we clearly observed a large heat burst equivalent to 110% of the input electric power in an open type electrolysis cell using Pd/0.1 MLiOD/Pt. Neither increase of neutron emission nor that of tritium content in the cell was observed in this case. Preliminarily helium was observed in the effluent gas but the detection was not 100% sure due to the possible contamination through PTFE from air. Although boiling has occurred many times in all five cells ever tested, this phenomenon happened only once before improvements have been made on the effluent gas system against contamination. A necessary condition seems very critical and marginal. Coincidental determination of heat and helium, therefore, has yet to be done. We can quantitatively determine the ^{4}He if the phenomenon repeats again.

Pd samples were degassed up to 770° C in a closed vacuum furnace. The gas was analyzed in the high-resolution mass spectrometer system. In this case, however, no trace of ^{4}He could be detected in the sample involving the large heat burst. Whether ^{4}He is extruded from this Pd sample or not, if it were heated up to much higher temperatures, aroused our strong interest recently. Experiment was firstly performed on another Pd sample that showed boiling several times. Furnace temperature was increased up to 1180° C. Above 1000° C pressure began to increase and large amount of ^{4}He was surely observed in the extruded gas. The pressure increase, however, could be mostly attributed to permeation of hydrogen from moisture of air through furnace body made of stainless steel (SUS316). As SUS316 is not stable at such high temperature, it is very difficult to determine whether ^{4}He came from the Pd sample or from permeation from air. In this paper, experimental results including additional improvements will be presented in detail.

Yasuhiro Iwamura, Takehiko Itoh, Nobuaki Gotoh and Ichiro Toyoda (Advanced Tech. Res. Cntr., Mitsubishi Heavy Industries, Ltd. Yokohama, Japan), "Correlation Between

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Behavior of Deuterium in Palladium and Occurrence of Nuclear Reactions Observed by Simultaneous Measurement of Excess Heat and Nuclear Products," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 56.

AUTHORS' ABSTRACT

We developed a new type of experimental apparatus for simultaneous measurement of excess heat and nuclear products with intent to induce continuous nuclear reactions in D2-Pd system. It consists of two parts; an electrochemical cell for calorimetry and a vacuum chamber for nuclear measurement as shown in Fig. 1. These two parts are separated by a palladium sheet. Deuterium atoms are loaded by electrochemical potential into one side of the palladium sample and released from the other side. There exits continuous flow of deuterium atoms through the palladium and we might expect that nuclear reactions last for a long term in the system, since it is considered that diffusion process of deuterium atoms in palladium is important to induce nuclear reactions.

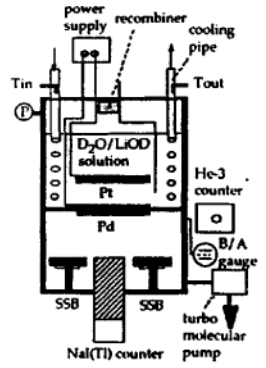

Fig.1 Schematic View of the Experimental Apparatus

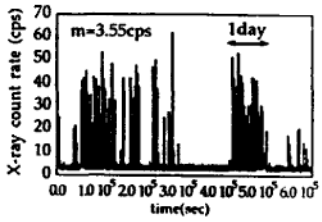

Fig.2 An Example of X-ray Emission

Fig. 2 shows an example of x-ray (energy range; 10 keV ~ 300 keV) measurement. X-ray count rate reaches over 10 times larger than that of background and the x-ray emission lasts for about 1 day.

Based on these experimental results, the correlation between deuterium behavior in palladium and nuclear reactions will be discussed.

H. Kamimura, T. Senjuh, S. Miyashita, N. Asami (R&D Center for New Hydrogen Energy, The Inst. of Applied Energy, Japan), "Excess Heat in Fuel-Cell Type Cells from Pure Pd Cathodes Annealed at High Temperatures," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 33.

AUTHORS' ABSTRACT

Excess heat has been observed in fuel-cell type cells using pure Palladium cathodes and apparently depended on their thermal treatments. All the Pd cathodes tested have had four-nine purity, but the treatment conditions of the cathodes have affected loading ratios and excess heat. The Pd cathodes with excess heat observed have been annealed for ten hours at a high temperature (850 or 1000° C) in a high vacuum environment. The excess heat from the samples has been 7-18 % of an electric input power.

The Pd cathodes, which had 4 mm of diameter and 20 mm of length, were made of four-nine Pd, melted in vacuum, processed in room temperature, and grind the surfaces. To increase loading capacity of deuterium, the samples were processed with various pre-electrolysis treatments. The major treatments were (1) a surface etching in aqua regia to remove surface defects and to clean the surface, and (2) a vacuum annealing to release the stress, to re-crystallize the grain, and to clean the surface by thermal etching. The etching in aqua regia was done before the vacuum annealing. Both the samples etched and not were prepared to examine the effect of the etching. The samples were etched for ten minutes in aqua regia. The annealing was performed for 1 or 10 hours at 850 or 1000° C at a vacuum environment of 1 mPa.

The fuel-cell type cell system developed by IMRA-Japan was used, which had pressurized cells applied a gas diffusion anode with the fuel-cell technology. The excess heat was evaluated by a rise of the cell temperature based on a calibration curve between input power and the cell temperature previously determined using Ni cathode. One non-treatment sample and eight variously treated samples described above were electrolyzed in the system for more than one and a half months. From the experiments, following significant results were acquired: (1) excess heat of 0.35 - 0.75 W (7-18%) was measured in only four samples annealed for 10 h at the temperature both of 850 and 1000° C, (2) the loading ratios of the samples with excess heat were reached to 0.85 - 0.89 of higher value than 0.80 of the non-treatment one, and did not declined at high current density supplied, (3) the aqua regia etching before annealing was not effective for D/Pd and excess heat in their experiments.

This study has been conducted under the consignment of New Energy and Industrial Technology Development Organization (NEDO).

A. Kubota, S. Takama, T. Saito, S. Sukenobu, N. Hasegawa, M. Sumi, N. Asami (NHE Lab., The Inst. of Applied Energy, Japan), "Development and Experiments on a Flow Calorimetry

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System," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 32.

AUTHORS' ABSTRACT

Demonstration experiments of excess heat generation have been conducted using "Fuel Cell Type Electrolysis System" since the start of the project, and "Mass Flow Calorimetry System" to confirm the excess heat generation from April 1995 in NHE Laboratory.

A mass flow calorimetry system has been developed with fuel cell type electrolysis cells, power supplies, vacuum insulators, water as coolant, temperature measurement equipment, and a personal computer. The power supply and multimeters are controlled by the personal computer. Total input power is kept 10 W. The data acquisition performs every 60 seconds. As a result of careful modification of the flow calorimetry system components, fluctuation of flow rate of <0.5 % and heat recovery rate of >98 % have been attained. It has been confirmed that excess heat of 0.05 W is measurable by heater calibration.

Excess heat has been observed by a fuel cell-type electrolysis system and the observations of excess heat of 7-18% has been reproduced in 11 cases, however the reproducibility issue still remains. Experiments have been performed to confirm these results and to find the condition for excess heat with the flow calorimetry system.

The 10 flow calorimetry experiments were performed until April, 1996. Excess heat is not yet measured by the flow calorimetry system. The same electrode materials that produced excess heat were installed in the flow calorimetry cells. The experimental conditions have differed, however, in detail from those of the fuel-cell-type electrolysis cell experiments in case of excess heat measurements.

This work was funded by New Energy and Industrial Technology Development Organization (NEDO).

L.T. Mizuno, T. Ohmori, T. Akimoto, K. Kurokawa, M. Kitaichi, K. Inoda, K. Azumi, S. Simokawa (Hokkaido Univ.) and M. Enyo (Natl. College of Tech., Japan), "Isotopic Distribution for the Elements Evolved in Palladium Cathode After Electrolysis in D_2O Solution," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 71.

AUTHORS' ABSTRACT

It was confirmed by several analytic methods that reaction products with mass number ranging from 2 to 82 are produced in palladium cathodes subjected to electrolysis in a heavy water solution at high pressure, high temperature, and high current density for one month. Isotopic distributions were radically different from the natural ones. The anomalous isotopic distribution of these elements shows they do not come from contamination. For example, natural copper is 70% Cu-63, and 30% Cu-65. But the copper found in the cathode was 100% Cu-63, with no detectable levels of Cu-65. Natural isotopic distribution varies by less than 0.001% for copper.

Electrolysis experiments were performed at a current density of 0.2 A/cm^2 or total current of 66 A to 33 cm^2 surface area for 2.76 x 10^6 s (32 days). The sample electrodes were analyzed for element detection by energy dispersive X-ray spectroscopy (EDX), Auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS) and electron probe microanalyzer (EPMA). **Thus, the presence of Ca, Ti, Cr, Mn, Fe, Co, Cu, Zn, Cd, Sn, Pt and Pb was confirmed.** AES and SIMS measurements were also made after bombardment by O_2- ions, thus removing surface layers, but the element concentrations at 1 micro m below the electrode surface were almost the same as at the surface. **The SIMS analysis showed other elements; As, Ga, Sb, Te, I, Hf, Re, Ir, Br and Xe.** These elements, except Xe, are difficult to detect by AES and EDX because the peaks are very close to each other, or lower than the limits of detection. Xe is naturally difficult to detect by EDX because it is in the gas state. The SIMS count numbers ranged from 10^3 to 10^6 where the background counts were as low as ~ 10. The intensity of Xe was 10 times larger than Pd; it may be that the gas was released by bombarding with O_2- ions which caused a temperature rise at the sample. **Large differences in isotopic distributions compared with the natural distributions were observed by the SIMS method for Cu, Zn, Br, Xe, Pd, Cd, Hf, Re, Pt, Ir and Hg. Especially notable was the fact that no Cu-65 peak was observed.** Except for a few cases, in generally the isotope abundances are higher for odd mass numbers and lower for even ones, as compared with the natural ratios. It must be admitted that these reactions have no solid, detailed theoretical basis yet, but in broad terms this can explain most of the elements which were observed. One may also imagine that as such transmutation reactions were presumably taking place during the electrochemical process.

T. Nakata, M. Kobayashi, M. Nagahama, H. Akita, and K. Kunimatsu (IMRA Japan Co. Ltd., Sapporo, Japan), "Excess Heat Measurement at High Cathode Loading by Deuterium During Electrolysis of Heavy Water," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 52

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AUTHORS' ABSTRACT

We reported excess heat data as a function of cathode loading by deuterium, D/Pd, using various kinds of Pd materials as a cathode in fuel cell type closed cells developed in our laboratory. Since then we have tried to reproduce the excess heat data by employing a different kind of calorimetry, mass flow calorimetry, at better cathode loadings because the previous data was restricted to the cathode loading lower than 0.86. The issue of electrolytic loading of deuterium into a Pd cathode was investigated in terms of the bulk and surface properties of the cathode, and it was concluded that in determining the maximum cathode loading the surface and the bulk properties plays an essential role respectively for a given bulk and a surface properties

We have employed five major approaches to improve the cathode loading based on these studies: (1) pretreatment of the Pd samples by either annealing at high temperature or by chemical etching in aqua regia, (2) application of the partial deload-reload cycles, (3) surface modification of the cathode surface by thiourea at its high concentrations employing a proton/deuteron conducting membrane totally impermeable to thiourea and water, (4) alloying with rhodium, and (5) application of Pd single crystal cathodes with (111), (110) and (100) orientations. The results of the D/Pd as well as the excess heat measurements will be reported and discussed.

R. Notoya, T. Ohnishi, Y. Noya (Catalysis Res. Cntr. and General Inst. of Radio Isotope, Hokkaido Univ., Japan), "Nuclear Reactions Caused by Electrolysis in Light and Heavy Water Solutions," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 73.

AUTHORS' ABSTRACT

The cold fusion occurring in the system of deuterium-palladium becomes gradually not-so curious owing to many scientists' efforts in the world, since Fleischmann and Pons proposed it, on the basis of finding anomalous large heat evolution during electrolysis in heavy water solution of lithium on palladium. On the other hand, by use of the, so-called, low overvoltage metals for hydrogen electrode reaction, large heat evolution and some amount of tritium, production were observed during electrolysis even in light water solutions of various alkali-metallic ions M^+. Furthermore, a few methods of chemical analysis of the electrolytes used for electrolysis provides some evidence of nuclear reactions, for example, Ca in K^+ solution, $^{131\text{-}140}X$ in $^{133}Cs^+$ solution etc.. The aim of this work is to elucidate the mechanism of the cold fusion occurring even in light water solutions.

In order to obtain more concrete information of nuclear products, the test cell was set directly in the measuring chamber of gamma-ray with a Ge-detector and electrolysis of alkaline solutions was carried out in it by use of a porous Ni or Pt/Pt cathode. Simultaneously, excess heat and neutron emission were measured. After electrolysis the electrolytes were analyzed by a liquid scintillation spectrometer.

The gamma-ray analysis showed the increase of each nuclear product during electrolysis, for example, ^{24}Na, ^{40}K and ^{134}Cs in the electrolyte, respectively. Moreover, ^{64}Cu was found in all electrolytes using porous Ni for electrolysis.

The presence of these nuclear products suggested that alkali metals and Ni underwent neutron capture, respectively and the product ^{64}Ni followed rapidly beta (-) disintegration. The combination of neutron capture and beta (-) disintegration is well known to occur in a nuclear reactor. The same type of reaction could be expected in the cold fusion cell.

In such systems, the mechanism of hydrogen evolution reaction had been determined by Matsuda group in Hokkaido University, by use of a method of the kinetic study, as follows:

$$M^+ + e^- \rightarrow M(I) \quad (I)$$

$$M(I) + H_2O \rightarrow M^+ + H(a) + OH^- \quad (II)$$

$$H(a) + H(a) \; A \; H_2 \quad (III)$$

where M(I), H(a) and A denote the intermetallic compound between M and the electrode material, an adsorbed or absorbed hydrogen and the rate determining step, respectively. The products of nuclear reactions described above suggested that the main intermediate M(I) of the hydrogen evolution reaction branched, i.e. as a whole, this electrode reaction have to be a chain reaction.

H. Ogawa, Y. Oya, O. Aruga, T. Ono, M. Aida and M. Okamoto (Res. Lab. Nucl. Reactors, Tokyo Inst. of Tech., Tokyo, Japan), "Dynamic Movement of Hydrogen Isotopes in Pulse Mode Electrolysis," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 63.

AUTHORS' ABSTRACT

The anomalous accumulation of deuterium has been discussed as one of the key factors to initiate the deuteron based nuclear reactions in solid states, like Pd metal, and to realize such an anomalous deuterium accumulation the dynamic movement of deuterium in solid state (i.e. dX/dt term in McKubre's equation) should be taking place by some techniques. The pulse mode electrolysis has been applied to realize the dynamic movement

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of deuterium and the anomalous accumulation of deuterium has been observed in the Pd cathodes which gave the excess heat and/or the excess neutrons, as reported previously. In the present work, the movement of the hydrogen isotopes was monitored by the loading ratios (D/Pd, H/Pd) evaluated by the electric resistance measurements as functions of the current density and the repetition time of the square pulse mode. At the same time, the authors tried to find some of physical meaning of the critical current density (200 mA/cm^2) that introduced by McKubre, SRI.

The experiments were carried out by use of the same size Pd electrodes which the authors have used in the new hydrogen energy researches, of 1.0M LiOD(H) as the electrolyte and of micro-Ohmmeters to measure the electric resistance of the electrodes as reported by Senjyu, NHE Sapporo Laboratory. The Pd electrodes were pretreated by annealing in vacuo at 850 ° C for 2 hours.

The findings obtained in the present work are summarized as follows.

(1) The movement of hydrogen isotopes in Pd cannot be found in the current density lower than 200 mA/cm^2.

(2) The movement of the hydrogen isotopes cannot be observed in the case of one hour repetition time even with large current density as 400 mA/cm^2.

(3) The movement of the deuterium can be observed very clearly in the cases of the high current density (>400 mA/cm^2) and longer repetition time (> 3 hours).

(4) The loading ratio of deuterium increases in the high current mode and decreases in the low current mode, while the loading ratio of hydrogen does in just reversal way.

(5) And the movement observed in the hydrogen is very slight.

(6) The loading rates of the hydrogen isotopes (estimated from the linear part of the loading curves obtained by the constant current electrolysis) are found to be proportional to the current density till 200 mA/cm^2.

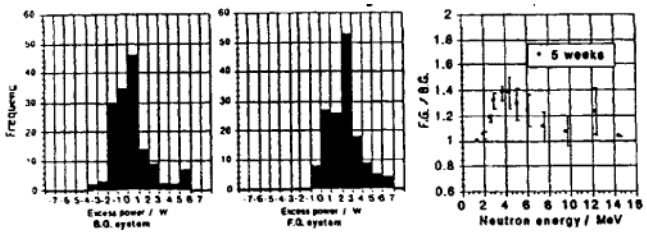
In the presentation, the details of the experiments will be presented and the optimum Conditions for the occurrence of the anomalous effects will be discussed.

H. Ogawa, Y. Oya, T. Ono, M. Aida and M. Okamoto (Res. Lab. for Nuclear Reactors, Tokyo Inst. of Tech., Japan), "Correlation of Excess Heat and Neutron Emission in PD-LIOD Electrolysis," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 64.

AUTHORS' ABSTRACT

To avoid the uncertainty, especially in the excess neutron evaluation, caused from the date difference between the foreground runs and the background runs, two sets of the experimental systems have been assembled with the excess heat monitoring systems and the neutron detection systems of NE213. The principles of the excess heat monitoring and the neutron detection are same as previously reported. The two experimental systems have been examined to determine the machine factors for the excess heat monitoring and the neutron detection in Pt-1.0 MLiOH electrolysis for about one month. The machine factor for the excess heat monitoring was determined to be 1.00 and the factor for the neutron detection was determined for each ten blocks in the 1024 channels of the MCA. The neutron energy spectrum was obtained after the correction by the machine factors.

Using the two experimental systems, the electrolysis operations to observe the excess heat and the excess neutrons have been carried out coincidentally under the same conditions which gave positive results with high reproducibility as reported previously. The 3 hours / 3 hours pulse mode electrolysis with 800 mA/20 mA current density was performed with Pd-1.0 MLiOH (as the background run) and Pd-1.0 MLiOD (as the foreground run), for 5 weeks. The electrolysis cell system was also improved in the control of electrolyte level and equipped a standard heat source for the temperature calibration for the excess heat monitoring. The Pd-electrodes were pretreated by fine mechanical polish and annealing in vacuo at 850° C for 10 hours.



The excess heat up to 6.5W (~2.5% of the input power) was observed in the Pd-LiOD electrolysis and the excess neutron emission was also observed with a main peak at around 4 MeV. The frequency histograms of the excess heat generation are illustrated in the figures to demonstrate the appreciable difference between the foreground run and the background run.

In the presentation, we will present the details of the experiments, reproducibility and discuss on the correlation between the excess heat generation and the excess neutron emission with the data obtained most currently.

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T. Ohmori (Catalysis Res. Cntr., Hokkaido Univ., Sapporo, Japan), T. Mizuno (Faculty of Eng., Hokkaido Univ., Sapporo, Japan) and M. Enyo (Hakodate Natl. College of Tech., Japan), "Production of Heavy Metal Elements and the Anomalous Surface Structure of the Electrode Produced During the Light Water Electrolysis on Au Electrode," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 72.

AUTHORS' ABSTRACT

Porous black deposits of 0.3 - 1 mg were obtained during the cathodic electrolysis on Au electrode in 0.5 M Na_2SO_4 or Na_2CO_3 light water solutions at a current density of 200 - 300 mA/cm^2 for 7 days. **It was found by SIMS analysis that the deposits are composed of Hg, Au, Pt, Os, Hf, Zn, Fe, etc. and the atomic abundances of these elements other than Au are evidently different from those of natural values. The production of these elements with intrinsically different isotopic abundances suggests the occurrence of some nuclear reactions during the electrolysis.**

SEM images of the Au electrode surface after the electrolysis showed formation of a number of micro craters with various sizes. The size of the largest one reaches ca. 30 µm diam. and 30 µm height. They look like volcanoes. The outside walls were made of very porous substances and the inside walls very fine porous substance and fine hexagonal crystals (200 - 400 nm). The structure of the porous substance is very much like that of the deposits mentioned above. Therefore, it would be natural to consider that the deposits are spewed out from these craters which are created by a micro-explosion occurred locally on Au surface, perhaps due to some nuclear reactions. The hexagonal crystals are considered to be Au(111) formed by recrystallization, the presence of which suggests that high temperature was evolved when these craters were created. From the SEM images it is seen that the craters were formed along the scraped lines on the Au electrode. It is then likely that the lattice defects play an important role to cause this reaction.

From the elements detected here, we can consider the following reaction scheme. Firstly, Hg is produced by

$$_{79}Au^{197} + _{1}H^{1} \rightarrow _{80}Hg^{198}$$

which would then convert into Pt, Os, and Hf by

$$_{80}Hg^{198} \rightarrow _{78}Pt^{194} + _{2}He^{4}$$

$$_{78}Pt^{194} \rightarrow _{76}Os^{190} + _{2}He^{4}$$

$$_{76}Os^{190} \rightarrow _{72}Hf^{180} + 2_{2}He^{4}$$

The production of other elements would be more complicated.

Y. Sakamoto, M. Imoto, K. Takai and T. Yanaru (Dept. of Matls. Sci. and Eng., Nagasaki Univ., Japan), "Calorimetric Enthalpies in the ß-Phase Regions of Pd Black-H(D) Systems," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 47.

AUTHORS' ABSTRACT

The enthalpies for the reaction of gaseous hydrogen and deuterium with palladium black in ß-phase region have been measured in the temperature range 323 K to 194.5 K and pressures up to about 7.6 MPa of $H_2(D_2)$ using a differential heat flow low temperature calorimeter.

The calorimetrically determined enthalpies, $\Delta H_{H(D)}$, for solution in the ß-phase regions of $0.7 < H/Pd < 0.9$ and $0.65 < D/Pd < 0.83$ for Pd black-H(D) systems become less exothermic almost in a linear fashion with increasing H(D) content, independently of temperature. The variation in $\Delta H_{H(D)}$ values with H(D) content are in agreement with that calculated from van't Hoff plots of the relative chemical potentials of hydrogen and deuterium. Enthalpies of almost the same magnitude are obtained from the desorption data. At the same H(D) content, the ΔH_H values for Pd black-H system are a slightly more exothermic; about 3 kJ(molH)$^{-1}$ than the ΔH_D values for the Pd black-D systems. Compared to the previously determined enthalpies for bulk Pd-H(D) systems, the $\Delta H_{H(D)}$ values of both the Pd black-H(D) systems are slightly more exothermic over the H(D) content regions. The corresponding entropy, $\Delta S_{H(D)}$, calculated by the calorimetrically determined $\Delta H_{H(D)}$ and the relative chemical potentials have a tendency to decrease gradually with increase of H(D) content independently of temperature, however there is no marked difference in the magnitude of the $\Delta S_{H(D)}$ values between the two systems. The present calorimetric data determined by gas phase measurements do not offer support for the generation of any "excess heat" up to D/Pd = 0.83 beyond that which is expected from the chemical reaction, because the values determined calorimetrically are almost the same as those derived from van't Hoff plots.

T. Senjuh, H. Kamimura, M. Sumi, S. Miyasita, N. Asami (R&D Center for New Hydrogen Energy, The Inst. of Applied Energy), and K. Mori (Tanaka Kikinzoku Kogyo K.K., Japan), "Study on Material Processing and Treatment for High Deuterium Loading," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 34.

AUTHORS' ABSTRACT

The electrochemical loading behavior of Pd cathodes in $LiOD/D_2O$ system has been studied experimentally. The material conditions of Pd cathodes have severely affected the

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loading ratios (D/Pd). The D/Pd has had effects on current densities supplied, current increasing patterns and anodic treatments.

Open cells were used to load deuterium into Pd electrolytically. The Pd cathodes, which had 2 mm of diameter and 50 mm of length, were used after various pre-electrolysis treatments. The major treatments were (1) a vacuum annealing to release the stress, to recrystallize and to clean the surface by thermally etching, and (2) a surface treatment to remove surface defects and to clean the surface. The annealing temperature and time were 850 or 1000° C and 1 to 10 h, respectively. The two surface treatments, etching in aqua regia and buff polishing, were used. The D/Pd values were estimated from the resistance of Pd measured by 4-wire Ohms measurements with AC signal during electrolysis, using D/Pd vs. resistance curve presented. The current of electrolysis was changed as a step. At the end of the electrolysis cycle, anodic treatments were performed.

The sample annealed at 1000° C got 0.95 of D/Pd higher than one of the sample with no treatment (about 0.85). As a result of the experiments, the higher annealing temperature (1000° C) got the higher D/Pd, and the etching in aqua regia was the better surface treatment than the buff polishing. It was confirmed that using the pre-electrolysis treatments achieved the higher D/Pd. The electrolysis current pattern and anodic treatment affected D/Pd. The effects are also discussed in the conference.

This study has been conducted under the consignment of New Energy and Industrial Technology Development Organization (NEDO).

T. Terazawa, T. Sano, Y. Kamiya, y, Oyabe, T. Oi (IMRA Material R&D Co, LTD., Japan), "Sustentation of Higher Deuterium Loading Ratio in Palladium," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 49.

AUTHORS' ABSTRACT

High deuterium loading and its sustentation are considered to be a key condition for generating excess heat.

In our previous work, two kinds of palladium treatment were found effective to increase the deuterium loading ratio. One is by etching a palladium rod with aqua regia, and the other is by annealing it under vacuum. After either/both of these conditioning, a loading ratio as high as D/Pd = 0.95 was achieved by our standard method of "step-up electrolysis." It is, however, often observed that the loaded deuterium started deloading after reaching a maximum loading ratio.

To maintain the achieved high loading ratio, we have devised a new technique associated with a finding that a cell voltage (the voltage between the anode and the cathode) during the electrolysis is the most important factor to control such deloading. For sustentation of the maximum loading ratio, to keep the cell voltage constant is found quite effective, though not perfect. Under such a constant voltage condition, electrolytic currents are observed to increase gradually, so that a corresponding resistive drop in some case sacrifices an overvoltage necessary to maintain the maximum loading ratio.

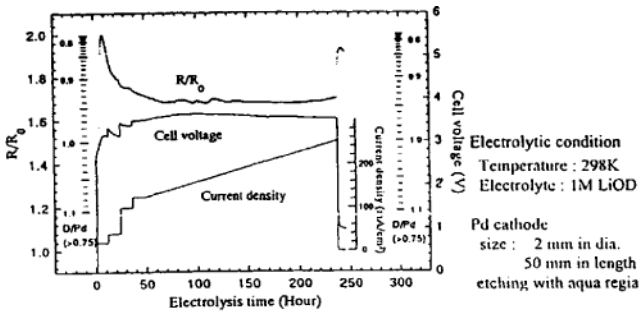

Fig. The effect of ramp electrolysis.

A successful example is shown in the figure above, where after attaining to the maximum loading ratio, the electrolytic currents were increased at a certain rate to restrain the overvoltage decrease, we call "ramp electrolysis," and the maximum loading ratio could be maintained for more than a week.

H. Yamada, H. Nonaka, A. Dohi, H. Hirahara, T. Fujiwara, X. Li and A Chiba (Faculty of Eng., Iwate Univ., Morioka, Japan), "Carbon Production on Palladium Point Electrode with Neutron Burst Under DC Glow Discharge in Pressurized Deuterium Gas," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 152.

AUTHORS' ABSTRACT

Highly non-uniform electric field condition, using a point-to-plane electrode configuration in slightly pressurized deuterium gas, was employed to confirm the cold fusion phenomena under glow discharge. One end of a palladium wire, 30 mm in length and 0.5 mm in diameter, was polished to be a point electrode. The electrode was vacuum annealed at 400° C for 3 hours, followed by loading of deuterium gas at room temperature for 24 hours. After the loading, a DC high-voltage was applied to the point electrode in 2 atm pressure deuterium gas for 24 up to 65 hours with a low background neutron measuring system. A helium-3 thermal neutron detector was used to determine the excess neutron emission over the measurement period of 24 up to 65 hours. The neutron detection efficiency was about 1%. The deuteron to palladium loading ratio was measured to be about 0.6.

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The DC glow discharge current around 100 μ A was measured to flow in the point electrode. A neutron burst was observed in 2 runs out of total 37 runs. The highest counting rate of 2,700 counts for 5 seconds is 9 x 10^4 times larger than the background counting rate of 22 counts per hour. Using an optical microscope, black deposit was observed on the tip of 2 electrodes which had given the neutron burst. To the contrary, the tip of other 35 electrodes was observed to keep its beginning appearance. **X-ray photo-electron spectroscopy have revealed the black deposit to be carbon, mixed with palladium at the surface of point electrode. The total amount of carbon impurity in the palladium electrode and in environment deuterium gas does not account for the large amount of carbon on the tip of electrode.**

The plausible explanation for the neutron burst and the carbon production is that high current density and its fluctuation by glow discharge would stimulate the accumulation of deuterons to induce the fusion in the bulk near surface of palladium point electrode. The relatively low loading ratio of 0.6 allow us to conceive that high loading ratio is not always necessary but high current density is rather an important factor for the nuclear reaction.

K. Yasuda, E. Nitta, A. Takahashi (Dept. of Nuclear Engineering, Osaka Univ., Japan), "Study of Excess Heat and Nuclear Products with Closed D_2O Electrolysis System," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Extracts*, pg 30.

AUTHORS' ABSTRACT

The high loading of deuterium into various batches of palladium is reported to be one of the key parameters which govern the generation of the excess heat and nuclear products. However only SRI International and IMRA-Japan have ever given phenomenologicl relation between loading ratios (D/Pd) of deuterium and excess heats by in-situ measurements, however, without detection of nuclear products.

In the present work, D/Pd ratios, excess heats and nuclear products were tried to measure in-situ in a closed heavy water electrolysis system. A new closed electrolysis cell which enabled heat measurement by using mass flow calorimetry method was manufactured. With the system, loading ratios D/Pd, output power and neutrons can be measured in-situ simultaneously. Mass spectrum analysis of upper-cell gas and Pd cathode by a quadrupole mass spectrometer and tritium measurement in a sampled electrolyte, before and after the experiment, are done by off-line techniques. The new cell has relatively large volume (738.4 ± 4.1 cc) and the electrolysis can be carried out at several-tens watts of input power. The heat recoverable efficiency was 95.6 ± 2.9%.

Five experiments have been done using a 0.2M LiOD electrolyte and plate Pd cathodes (25 x 25 x 1 mm). Several pre-conditioned palladium plates (cold worked, annealed, with or without copper surface layer) were used for the cathodes. In the fourth experiment with the cold worked and copper layered (0.95 μm) cathode, excess heats up to approximately 4W were produced by stepping up input power to about 45W maximum. In this run of the fourth experiment, D/Pd ratios were observed to be almost constant (~ 0.83 with small variation) in spite of drastic change of current by the stepping-up. For experiments with no excess heats, D/Pd ratios changed largely by the current stepping-up. However, during the excess heats, nuclear products (neutrons) were not observed over the 3 σ limit of the background level, and clear increases of He-4 and tritium in gas and electrolyte were not observed either. Because of a few experiments, the correlation or non-correlation between the generation of excess heat and nuclear products can not be confirmed.

The second closed cell is under manufacturing in order to establish the more confident measurement system and study the correlation between excess heats and the degree of loading ratios D/Pd using simultaneously different pre-conditioned cathodes.

H. Yuki, T. Sato, T. Ohtsuki, T. Yorita, Y. Aoki, H. Yamazaki and J. Kasagi (Lab. of Nuclear Sci., Tohoku Univ., Sendai, Japan), "Reaction Rates of the D+D Reaction in Metal at Very Low Energies," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 54.

AUTHORS' ABSTRACT

Nuclear reactions at very low energies are considered naturally to be affected by the environment, since surrounding electrons contribute to reduce the effective Coulomb barrier between the projectile and target nuclei. Actually, recent experiments showed the non-negligible effect caused by bound electrons in low energy reactions with gas target. One might expect much stronger effects than caused by bound electrons when the nucleus is embedded in metal, since the electrons both in the metallic band and in the hydrogen-induced s-band can contribute to the screening effect. The previous investigation with deuteron energies down to 5 keV, however, concluded that the effect of the metal cannot be seen for E_d > 5 keV. Thus, the reaction rates of the D+D reactions in metal have been investigated with further lower energies, down to 2.5 keV in the present work, in order to explore the effects of metal environment.

The experiments have been carried out using a deuteron beam obtained from a low-energy deuteron beam generator which was installed in our laboratory last year. The generator consists of

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a duoplasmatron ion source, a beam analyzer magnet, electrostatic lenses, a decelerator electrode and a filter magnet for rejecting neutral beams. The electric current on the target was measured during the bombardment; the current was about 0.5 mA for E_d = 6 keV and 0.1 mA for 2.5 keV. Protons emitted in the D+D → p + T reaction were measured during the irradiation of deuterons with bombarding energies below 7 keV. A ΔE-E counter telescope consisting of 50-mm and 200-turn thick Si detectors are employed. So far, TiD_x, and Yb plates were bombarded.

Since the yields of protons drops exponentially as the deuteron energy decreases, measured spectra were inevitable to be polluted with electric noise for the runs below 4 keV. Coincidence measurements employed in the present work resolved the noise problem. Protons are clearly separated from the noise in a two dimensional spectrum. The obtained proton yield for each bombarding energy were normalized to the one at E_d = 6.5 keV, so that the relative values of the reaction rate were deduced as a function of the bombarding energy. The deduced reaction rates were compared with those expected for the D+D reactions with bare nuclei.

From the comparisons we can make the following statements: The reaction rates are really enhanced when the D+D reactions occur in metal at very low energies (at least lower than 5 keV). For Ti metal, observed enhancement is only about 10% below 4 keV, while about 30% of the enhancement is observed for Yb metal for $E_d < 5$ keV. These enhancements can be interpreted as the screening of the Coulomb potential due to surrounding electrons; the values of the screening potential are about 20 eV for Ti and 60 eV for Yb. Further systematic studies for various metals and in various conditions are highly desirable to make clear the mechanism of the screening and to find how to control it.

EUROPE

L. Bertalot, F. De Marco, A. De Ninno, A. Frattolillo, A. La Barbera, F. Scaramuzzi, V. (Assoc. EURATOM-ENEAsulla Fusione, Frascati, Rome, Italy), "Report on the Research Activities On Cold Fusion at ENEA Frascati," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 45.

AUTHORS' ABSTRACT

In the last year our research has been dedicated mostly to two main lines, which are summarized here, and will be reported at the Conference:

The unpredictability of the heat excess production, together with the well established correlation of the heat excess with the D/Pd ratio, has promoted research aimed to master the techniques for obtaining high charging ratios. In order to do this, the measurement of the D/Pd ratio through the resistivity of the sample has been settled. Different loading procedures have been investigated, comparing their results. The study of the characteristics of the material from this point of view has been initiated and some particular results will be the object of topical communications in this Conference. Furthermore, mathematical simulations and theoretical evaluations have been performed, aiming to a better understanding of the dynamics of D in Pd, and its links with the most relevant metallurgical parameters. Experiments on heat excess measurement have been continued.

A step forward has been performed in the development of a circuit intended for the measurement of traces of ^4He in the gases emerging from the electrolytical cells. An ultravacuum system has been realized, in which all components with the exception of the helium isotopes are eliminated, thus permitting an accurate measurement of the latter. The calibration of the instrument is presently in course.

E. Botta, T. Bressani, D. Calvo, C. Fanara (Dipt. di Fisica Superiore, Univ. di Torino, and INFN- Sezione di Torino, Italy), F. Iazzi (Dipt. di Fisica, Politecnico di Torino, and INFN-Sezione di Torino, Italy), "Measurements on ^4He Production from Pd/D_2 Systems in Gas Phase," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 29.

AUTHORS' ABSTRACT

We have already reported results on ^4He production from Pd/D_2 System in Gas Phase, obtained by an experimental apparatus consisting of a cell coupled on-line with a high resolution Q-mass spectrometer ULVAC HI-RESOM 2SM. The cell contained a Pd sheet (8 x 1 x $5 \cdot 10^{-3}$) cm^3 and the pressure of D_2 gas could be varied from 10^{-6} to 2 bar. The D/Pd ratio α was continuously monitored by means both of thermodynamic measurements (p, V, T) and by the resistivity variation of the sample. A constant electric field of a few hundreds of mV/cm could be applied to the Pd sheet in order to speed up the loading and increase the maximum value of α. In a first series of measurements we observed:

1) the electric field is effective in producing electromigration of D^+ towards the cathode,

2) in one experiment we observed ^4He production.

We have modified the cell in order to have a better control of the temperature along the Pd sheet, by means of an increased number of thermocouples, and we have now restarted a new series of measurements with the following schedule:

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a) search for ^{4}He emission from the Pd sheet as a function of the D_2 pressure and of the electric field,

b) an improved study of the absolute calibration of the a values as a function of the resistivity measurements.

The results obtained will be presented at the Conference.

F. Celani, A. Spallone, P. Tripodi, D. Di Gioacchino, S. Pace (INFN, Lab. Nazionali di Frascati, Italy), P. Marini, V. Di Stefano (EURESYS, Rome, Italy), A. Mancini (ORIM S.r.L., Italy), "High Power μs Pulsed Electrolysis using Long and Thin Pd Wires in Very Diluted LiOD-D_2O Solution: Observation of Anomalous Excess Heat," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 37.

AUTHORS' ABSTRACT

We have tested thin and long pure Palladium wires (mainly, diameter of 100 μm, length of 160 cm), using both HV-DC electrolysis and high power-high frequency electrolysis (peak current up to 25A, peak voltage up to 270V, pulse width between 200 ns and 5000 ns, rate between 100 Hz and 50.000 Hz) in a 0.25 mN LiOD-D_2O solution.

The experimental set-up consists of a PTFE cylinder (4 cm of diameter), a Pd wire turned around it and a Pt wire (1 mm of diameter) turned in the same way at 1 cm (constant distance) from the Pd wire. This device is located in a graduated cylindrical glass (chemical grade) filled with the electrolytic solution. A specifically designed electronic circuit has been developed to produce a very high frequency-high voltage electrolysis. Read-out circuits are linked to a PC to acquire cyclically (every 8 seconds) the signals from the sensors.

Regarding the heat measurements, we used a flow calorimeter. A Joule heater, switched on and off cyclically every 3 hours, has been over-imposed, in order to continuously calibrate the apparatus.

In some previous exploration experiments (with a simple bath-calorimeter), probably because of the particular cathode geometry (specifically developed in order to enhance the Electromigration Effect), the excess heat reached the value of about 70 W for several hours (about 200% of the input power). Moreover, correlation has been found between the excess heat and the electrical resistivity (by AC measurements) of the Pd-D wire.

Systematic studies, with the flow calorimeter previously described, are in progress in order to reproduce the results using a new wire.

P.L. Cignini, G. Gigli, D. Gozzi (CNR-CSTACAT, Univ. di Roma, *La Sapienza*, Italy), M. Tomellini (Dept. di Sci. & Tech., Chimiche, Univ. di Roma, *Tor Vergata*, Italy), E. Cisbani (INFN, Lab di Fisica, Italy), S. Frullani (Lab di Fisica, Italy), and G.M. Urciuoli (INFN, Lab di Fisica, Italy), "X-Ray, Heat Excess and ^{4}He in the Electrochemical Confinement of Deuterium in Palladium," ICCF-6, *Program and Abstracts,* pg 25.

AUTHORS' ABSTRACT

After seven years of worldwide research activity in the field of the cold fusion the energy balance of the observed anomalous phenomena is still far from to be completely proved. This contributes to maintain skepticism in the scientific community. We believe that the best arguments to support the field can arise from those experiments in which excess heat and nuclear evidences are correlated. Since 1989 our activity was addressed to this end with a continuous effort to improve the reliability of the measurements. We dedicated a particular attention to the neutron detection and due to the high efficiency and overall quality of the system the negative results have found the conclusion that, even in agreement with other reported findings, the neutron, as well as the tritium production, are very low-probability channels in the overall process. Furthermore, we did a very great effort to obtain reliable on-line measurements of ^{4}He and this was finally obtained by a home-made system based on a high resolution and high sensitivity ($\approx$ 7 pA/10^{12} atoms of ^{4}He) quadruple mass spectrometer (QMS) connected by an on-line automatic sampling device where the occurrence of air contamination was definitely avoided and, moreover, continuously monitored through the $^{20}Ne^{++}$ signal. At set intervals ($\geq$ 900 s), a sample of 150 cm^3 of the electrolysis gas mixture (N_2, D_2, O_2, D_2O vapor, ^{4}He if any), escaping from the calorimeter-electrolytic cell and made to flow through a deuterium cutting system, is sucked by LN_2 charcoal trap which absorbs almost all the gases except to ^{4}He which are injected at low pressure ($\leq 5 \times 10^{-2}$ mbar) in the QMS chamber where the pressure is generally $\leq 1 \times 10^{-7}$ mbar. In a four-cells experiment lasted 950 h more than a thousand samplings were performed providing for each cell a satisfactory time-resolved structure of ^{4}He release. All these data have been then correlated by a simulation procedure to the measured heat excess by computing the expected ^{4}He at the time when the sampling was effectively done. Further a very important result we aim to present is a clear-cut evidence of the no chemical nature of phenomena we are dealing with. A x-ray film positioned at 5 cm far from the cell has been impressioned with a series of spots roughly reproducing the image of the cathode. An other x-ray film located in the same position, at the same time and for the same period in front of the blank cell was not impressioned at all. Through the microdensitometry of x-ray film and calibration of the optical density against the x-ray

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exposition, each spot was characterized by position, dimension and intensity. Since all the geometrical parameters and nature of all the materials interposed between cathode and film are exactly known, it has been possible to calculate as function of the energy of radiation the I/I_O ratio. The spot-nature of the impressioned film is very intriguing and it could support more than one explanation about the main process occurring in the source but in absence of a clear understanding of it, in order to estimate the value of the involved energy, we oriented to treat the matter in term of classical physics of radiation by taking into account the cathode structure. This was bundle type having 150 Pd wires of 250 μm diameter. The analysis of such data leads to the conclusion that because the energy of radiation and the total energy associated to all the spots on the whole solid angle were, respectively, evaluated to be (89 ± 1) keV and (12.0 ± 0.4) kJ, we are dealing with a phenomenon which is originated at nuclear level and not at atomic level (soft γ-ray instead of hard x-ray) and it is not the principal source of energy being ≈ 0.5% of the energy measured by calorimetry in the same interval of time.

G. Lonchampt (CEREM/CENG, France), L. Bonnetain, P. Hicter (ENSEEG, Saint Martin d'Heres, France), "Reproduction of Fleischmann and Pons Experiments," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 66.

AUTHORS' ABSTRACT

The French Atomic Energy Commission, in association with the ENSEEG (Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie de Grenoble) started in 1993 a program of verification of the results of "cold fusion" published in 1993 by Fleischmann and Pons. Experiments have been performed in calorimeters identical to the ones used by Fleischmann and Pons.

We point out here that these types of experiments can be analyzed in three temperature domains:

- At low temperatures, below 70° C, excess enthalpy is the difference between the heat radiated to the water bath, and the enthalpy input due to electrolysis.

- At intermediate temperatures, between 70° C and 99° C, excess enthalpy is the difference between the heat radiated towards the water bath plus the enthalpy contents of the gas stream: plus the variation of enthalpy of the contents of the calorimeter (because of the fast temperature variation observed) and the introduced electrical enthalpy.

- In the boiling regime (without condensation), excess enthalpy is calculated from the difference between the total amount of water contained in the calorimeter evaporated and the theoretical quantity of water that should be evaporated by the energy introduced in the calorimeter (i.e. the enthalpy input due to electrolysis minus radiated enthalpy at boiling temperature).

Six calibration runs with platinum cathodes and 17 runs with different palladium type cathodes have been performed.

At low temperature, 8 experiments have produced an excess energy rate between 1 and 5%. In the intermediate regime, the water vapor carried away by the gases of the electrolysis are large, and cannot be evaluated precisely. This makes the analysis difficult, and has not been carried out fully yet. We discuss this point in detail.

At boiling, three positive experiments have been successful, giving excess enthalpies rates of 80% to 150%.

We present the results obtained with different types of cathode materials: pure, annealed and cold worked palladium and alloys (Pd-Rh and Pd-Ce).

In conclusion, we confirm the results published by Fleischmann and Pons, more particularly in the boiling regime.

G. Preparata, E. Del Giudice, R. Pagliarani, D. Uglietti (Dipt. di Fisica, Univ. di Milano, INFN, Italy), R. Barni, R. Siea (LEDA Srl, Milano, Italy), "Cold Fusion Phenomena in Modified Fleischmann-Pons Electrolytic Cells," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 51.

AUTHORS' ABSTRACT

We have conducted a large number of experiments with electrolytic cells whose cathode is a thin (50 μm) Pd-wire and its solvent is either D_2O or H_2O.

In the "black" cells (D_2O) we have observed remarkable quantities of excess heat and some puzzling physico-chemical phenomena, which all can be related to basic Cold Fusion processes affecting deuterons inside the Pd matrix in a new, high x (x = D/Pd) phase, the γ-phase.

The various aspects of the γ-phase, both experimental and theoretical, will be discussed, together with the dynamics of the different Cold Fusion processes.

T. Roulette, J. Roulette, and S. Pons (Center de Recherche Scientfique, IMRA Europe, Valbonne, France), "The Icarus 9 Calorimeter: Summary of Three Years: Designing, Testing and Operation of this Device at the IMRA Europe Science Center," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 36.

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AUTHORS' ABSTRACT

The design, testing, and operational stages of a novel high power dissipating heat flow calorimetric system developed at IMRA Europe will be described. The calorimeter has been used to investigate the generation of excess enthalpy in the electrolysis of D_2O electrolytes at Pd and Pd alloy cathodes.

The unique features of this calorimeter are (a) the ability to make long term measurements for (b) extended time periods (up to several months) at (c) high input powers and at high electrolyte temperatures, up to the atmospheric pressure boiling point of the electrolyte. Further, (d) there is negligible loss of the electrolyte due to evaporation, and (e) there is no recombination of the evolved deuterium and oxygen in the cell.

We discuss the results for an number of control experiments, unsuccessful experiments, and successful experiments lasting over periods of several months.

C. Sanchez, F. Cuevas and J.F. Fernandez (Dpto. de Fisica de'Materiales Univ. Autonoma de Madrid, Spain), "Searching of Neutron Emissions Induced by Electrical Currents and Phase Transitions in Titanium Deuteride Films," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 46.

AUTHORS' ABSTRACT

The activation of nuclear phenomena in M-D systems requires non-equilibrium conditions. It has been published the production of neutrons from Ti-D samples during the circulation of D.C. currents or during some phase transitions, although we were unable to detect such phenomena in the (δ-ϵ) phase transition in TiD_X ($x > 1.7$). Therefore, our aim still is to study titanium deuteride, with well controlled properties of the initial titanium metal, under several non-equilibrium conditions.

To this aim we have deposited a 150 μm thick film by thermal decomposition of TiI_4 on a W substrate with very low content of gaseous impurities what will enhance the D uptake. The deposition apparatus allows us to monitor the electrical resistance of the films and to impose programmed electrical currents through it up to 15A. Afterwards, the sample is charged with D gas in the same deposition chamber to prevent its oxidation.

We have applied different electrical current patterns through the sample without changing its D content (TiDx, $x \cong 1.5$) neither its crystallographic structure (δ phase). In a second set of experiments the sample was transitioned around the δ-ϵ and ß-δ phases by suitable thermal cycling. A double liquid scintillation system, composed of BC501 and NE213 detectors, allowed us to monitor possible neutron emissions with a detection limit of 10^{-21} f(dd)$^{-1}$s^{-1}. The obtained neutron counts in all experiments match well with the natural background level however, some signals seem to excess such level during long time cycling of the sample at high electrical currents. A detailed discussion of the results will be given at the Conference.

RUSSIA

A.B. Karabut, I.B. Savvatimova (SIA "Luch," Moscow region, Russia), "Excess Heat Registration in High Current Density Glow Discharge with Various Cathode Materials," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 79.

AUTHORS' ABSTRACT

Results of registration input electrical power and output heat power in high current density glow discharge in D_2, H_2, Ar, using cathode samples from various materials are submitted. The measurements were conducted using a continuous flow calorimeter. Pulsatile direct current with frequency from 50 Hz up to 1 MHz and with pulses of a various duration was used. The output heat power was measured with error ± 0,05 W for total power 10-30 W.

Excess heat power (1-7 W) for systems Ni-H_2, Nb-H_2, Pd-D_2 with a efficiency of 115-190% is registered. Two characteristic areas with maximum excess heat (up to 7 W for Pd-D_2) are found out. The first area is - small density of a current (up to 10 mA /cm^2) and high loading D_2 in Pd, second there is - high density of a current (30-40 mA /cm^2) at small loading D_2 in Pd.

Excess heat was registered also with use of ceramic proton-conducting solid electrolytes.

Comparison received excess heat is made (up to 100 kJ) with quantity produced impurities nuclides in volume cathode samples for possible nuclear reactions.

A.B. Karabut (SIA "Luch," Moscow region, Russia), "Registration of High-Energy Products in High Current Density Glow Discharge," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 80.

AUTHOR'S ABSTRACT

Results of research high-voltage (up to a few tens kV) and high current (up to hundreds A) of pulses nanosecond of a duration are submitted, which are generated in low-voltage glow discharge with high density of a current. Amplitude spectra of a voltage of pulses for the discharge in H_2, D_2, Ar are received at various materials of a cathode. Penetrating radiation

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(presumably fast electrons) with the help of a x-ray film and various multipliers is registered.

Results of measurement electronic and x-ray emission cathode samples after switch off of a discharge current in the area from 2 keV up to 1 MeV are indicated.

Possible mechanism of radiation of beams fast electrons, as result of interaction phonons of high energy (the phonon laser P. Hagelstein) with electrons of a solid (a electronic laser) is discussed.

A.B. Karabut (SIA "Luch," Podolsk, Moscow region, Russia), "Possible Phenomenological Model of Initiation of Nuclear Reactions in Solid," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 81.

AUTHOR'S ABSTRACT

On the basis of experimental results possible model of processes of transformation of energy of a flux low energy ions in a solid is considered, which includes: generation optical pole phonons with energy 1-500 eV, in a solid at the expense of components of nuclear deceleration of a ions flux, multicascade unharmonic processes of the third and fourth orders (merge two and three phonons in one with a increase of frequency) and formation of populated level of nuclei with effective phonon in temperature up to a few tens and hundreds keV (a phonon laser of P. Hagelstein), Interaction populated of phonon levels with electrons and generation of fast electron beams (electronic laser) is discussed. **Opportunity of realization between nuclei with such phonons by excitation of nuclear reactions of a following type is considered: $A + B = C^* + D^*$. These reactions can be resonant (long-haul acting) under a following condition: the difference between energy of reaction by received new nuclei C^* and D^* and energy of excited nuclear levels C^* and D^* is size small (up to a few tens keV).**

It is possible to mark two types of nuclear reactions 1- with formation radioactive nuclides, which are observed practically for any working gases including Ar and cathode samples from the majority of metals with intensity 10^2-$10^3 s^{-1}$, 2- reactions proceeding for some metals with H_2 and with D_2 by intensity 10^{11}-10^{12} s^{-1} and forming stable nuclides with excess heat without decelerated γ -radiation. The removal of energy from the excited levels C^* and D^* can be to realization by the way electron - multiphonons of interaction (inradiative transitions in a solid), when the energy is transmitted simultaneously to a plenty of thermal phonons of a crystal lattice.

A.G. Lipson, B.F. Lyakhov, D.M. Sakov, V.A. Kuznetsov, T.S. Ivanova (Inst. of Physical Chem., Russian Academy of Sci., Moscow, Russia), "Excess Heat Production and Nuclear Ash in PdO/Pd/PdO Heterostructure After Electrochemical Saturation with Deuterium," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program Abstracts*, pg 62.

AUTHORS' ABSTRACT

Heat production, nuclear ash and electrophysical processes in PdO/Pd/PdO (Au/Pd/PdO) heterostructures (Pd sample thickness $h_1 = 50$ μm; PdO coating thickness $h_2 = 500$ Å) electrochemically saturated with deuterium (hydrogen) have been investigated. It was shown in after electrolysis period a strong heat flash with duration of 2-7 s and energy density of 60-100 J/cm^2 was observed for Pd/PdO:D(H) sample placed in air atmosphere. The thermal energy of each flash was approximately 2-5 times higher than the energy supplied to the sample during electrolysis. Neutron- and γ-emissions accompanied the heat production have been investigated.

It was established that neutron emission has a burst like character (with intensity up to $I_n = 5 \cdot 10^2$ n/cm^2 in the time gate of 1 ms) and precedes the heat evolution. In the process of deuterium desorption from the sample the γ-emission was detected with intensity maxima in the ranges of $E_1 = 3.8 \pm 0.5$ MeV and $E_2 = 6.3 \pm 0.2$ MeV as well as the sharp low intensity line of $E_3 = 2.22$ MeV (width about of 10 KeV).

With the help of temperature and current dependencies of Pd/PdO:D(H) systems electroconductivity measurements as well as variation of samples linear dimension registration upon deuteration and desorption procedures the deuterium localization in cluster form at the Pd-PdO interface was established.

It has been shown that Pd/PdO;D_x samples at $x \pm 10^{-3}$ possess by metallic character of electroconductivity in the temperature region of 4.2 - 300 K, that is caused by quasimetallic properties of deuterium clusters.

On the basis of data obtained the model of thermal and nuclear processes in Pd/PdO;D heterostructure has been proposed. This model involves the conversion of elastic energy stored in heterostructure during electrolysis period by means of cold fusion reactions (with coherent transfer of virtual neutron) into disintegration energy of metallic deuterium clusters including its atomization and moleculization one.

A.L. Samgin, S.V. Vakarin, V.S. Andreev, V.A. Khokhlov, E.S. Filatov and V.P. Gorelov (Inst. of High-Temp. Electrochem., Russian Academy of Sci., Ekaterinburg, Russia), "Solid Protonic Conductors: Conductivity, Structure, Proton Traps, Phase Transitions, Excess Heat and Neutron Anti-Effect," ICCF-6,

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October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 59.

AUTHORS' ABSTRACT

In Proceedings of ICCF4 and ICCF5 we reported about excess heat and neutron bursts emitted by high temperature proton conductors (HTPC) of $ACe_{1-x}d_xO_3$ type (A- Ba or Sr, d - dopant, e.g., Nd, Dy, Yb). It has been proposed that a nature of conductivity is of considerable importance in the understanding of anomalous effects in deuterium-solid systems.

These effects in HTPC can be correlated to peculiarities of structural and electric properties. At the moment the mechanism of conductivity is not fully understood in these systems. To account for cold fusion processes such established experimental facts as manner of localization of protons (or deuterons) in the lattice, trapping - escape of protons and them clustering in conductivity channels, temperature regions of proper protonic conductivity, non-reproducibility and oscillations of normal electrical properties must be important. Analysis of some peculiarities of conductivity of HTPC shows that conductivity could not be satisfactorily explained without considering interaction between protons as well as protons and lattice environment. Thus the available electrochemical data on ionic transport are attested that processes of nuclear interactions simultaneously occurs which may results in cold fusion phenomena. Our X-ray studies shows that the structure of these materials is orthorombic in the normal conditions. The unknown phase transition at 445° C and similar behavior at other points in the range to 1000° C were found. Pass through a region of phase transition is correlated to heat. Modifications of microstructure induced by temperature variations can occur and transformations to higher symmetry of lattice can take place. It has been found that parameter of lattice was decreased after experiment in which the excess heat were obtained. Dopant compound and atmosphere may also effect on proton distribution. Formation of $SrCO_3$ and CeO_2 phases as well as transition from proton conductivity to electronic one were found. This may be related to disappearance of anomalous phenomena.

One paradox event was observed. The influence of background on neutron emission and neutron anti-effect were found depending on conditions and chemical purity of ceramic. The last-mentioned effect is related to decay of neutron background measured within protection jacket containing the electrochemical cell with ceramic (as rule near phase transitions and with many-seconds duration). Analogous effect we observed under electrolysis of deuterium containing molten salt eutectic.

Irina B. Savvatimova, Alexander B. Karabut, Aleksey D. Senchukov, Ivan P. Chernov (Scientific Industrial Assoc., "Lutch" Podolsk, Russia), "Transmutation Phenomena in the Palladium Cathode after Ion's Irradiation at Glow Discharge," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 144.

AUTHORS' ABSTRACT

Observation of the anomalous stable and unstable impurities and isotope shift in the palladium cathode after D, H, Ar, and Xe glow discharge (GD) experiments have been made by different methods in more detail than early reports. The concentration of some impurities and isotope shift in Pd cathode after GD plasma experiments depends on the current density, kind of the ions, the distance from irradiated surface and the time interval after (GD) switch off.

The most change of the isotope natural abundance in the deuterium irradiated Pd was found for Pd and Ag near the surface shortly after GD switch off by SIMS.

Maximum of the impurities increasing was observed for deuterium experiment. Quantity of the impurity decreased from D to H, to Ar + Xe (by EDS method). It correlated with heat measurements. Maximum impurity contents were for elements Ag, Cd, In, Br, Kr, St, Y, Zr, Ge. As with atom numbers 47-49, 42, 44, 35, 36, 38-40, 54 (by EDS).

Maximum isotope shift in the isotope natural abundance of the Pd was rounded after irradiation by Ar + Xe. For example, Pd^{104} decreasing was to 8% after hydrogen irradiation and increasing to 16% after Ar + Xe irradiation later 3 months (by SIMS after deleting 100 nanometre). Mass 107 (only!) was obtained in the Pd cathode sample after Ar + Xe irradiation three months later. Probably, it depends on the deferent life period of the isotopes Pd^{109} and Pd^{107}.

We registrated masses 109 and 107 in ratio = 10/1 and 3/1 after deuterium experiment in a few days. The blackening of the x-ray films by Pd, which were shielded from ion's irradiation or were below irradiated foils of the Pd or other different metals, may be as a result of the Pd^{109} radiation. Time dependence of the blackening decreasing correlated with period of the life of the Pd^{109}.

Increasing of the mass 110 > 25% and decreasing of the 105 mass > 12% was observed for the irradiated deuterium Pd shortly after other series of the experiments. This is more, than the cumulative measuring error. Masses 107 and 109 was presented in this case too.

Most isotope shift for Ar + Xe experiment with Pd cathode may be explain as a result of the decay (fusion reaction) excited Pd.

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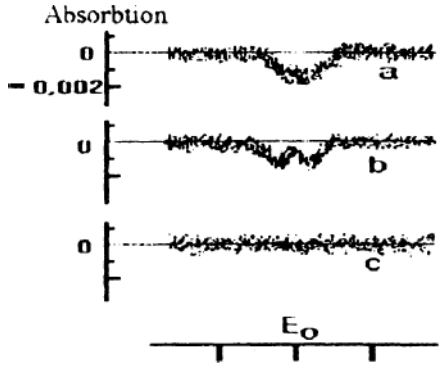
V.I. Vysotskii (Kiev Shevehenko Univ., Ukraine), A.A. Kormlova (Moscow St. Univ., Moscow, Russia), I.I. Samoylenko (Gamaleya Inst. of Epidemiology and Microbiology, Moscow, Russia), "Experimental Discovery of the Phenomenon of Low-Energy Nuclear Transmutation of Isotopes ($Mn^{55} \rightarrow Fe^{57}$) in Growing Biological Cultures," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 75.

AUTHORS' ABSTRACT

Hypothesis of possibility of nuclear transmutation of elements and isotopes in biological structures has been repeatedly discussed during the last decades.

We have carried out investigations aimed at the discovery of nuclear transmutation of isotopes in microbiological cultures. We believe that this aim can be achieved only if an isotope obtained in the process of transmutation does not have any analogues in the nutrient medium where the culture is growing (along with inevitably present admixtures of this isotope). Therefore all experiments, like H. Komaki, are hardly convincing because they don't meet this condition.



We have conducted a series of experiments based upon new technology employing the precise methods of Mossbauer spectroscopy. The experiments are based on the expected $Mn^{55} + d^2 = Fe^{57}$ reactions in growing microbiological culture in heavy-hydrous (D_2O) sugar-salt nutrient medium deficient in Fe but additionally containing Mn. The reaction results in generation of rare stable Fe^{57} isotope, concentration of which in the natural iron (mainly Fe^{56}) is very low (≈ 2.2%). The Fe^{57} isotopic obtained in small quantities can be easily discovered by means of the Mossbauer effect. The Mossbauer effect allows to monitor the isotope contents of all components of the nutrient medium, the initial culture and all samples of initial culture after its growth has finished, taking into account all varieties of experiments.

The research was carried out on the basis of bacterial cultures D. Radiodurans M-1, B. Subtilis GSY 228, E. Coli K-1 and yeast culture Saccharomyces cerevisiae T-8, selected according to the possibility of their growth in light and heavy water media. Previously obtained cultures after centrifuging, washing and post-growth were placed in a flask with sugar-salt nutrient medium containing salts of Mg, Ca, K, ammonium tartrate, sucrose and pure water (D_2O with Mn in transmutation experiments, H_2O with Mn or D_2O without Mn in control experiments). The figures present in the Mossbauer (Fe^{57}) spectrums of Saccharomyces cerevisiae and D. Radiodurans cultures grown during 72 hours in optimal medium (D_2O and $MnSO_4$), figure c - in control experiments and in experiments for investigation of all components of the nutrient medium (E_O - central energy of Mossbauer radiation and absorption in Fe^{57}). Total mass of the culture was 0.28 g, total mass and full numbers of atoms of created isotope Fe^{57} were $m_{a,b} \approx 10^{-6}$ g and $N_{a,b} \approx 10^{16}$. The transmutation coefficient in reaction $Mn^{55} \rightarrow Fe57$ equal $\lambda \approx (2 \pm 0,5) \times 10^{-8}$ (nucleus Fe^{57} per second and per single Mn^{55} nucleus). The theory of cold transmutation isotopes in grown culture is discussed.

CHINA

Xing Z. Li, Wei Z. Yue, Gui S. Huang, Hang Shi, Lan Gao, Meng L. Liu (Dept. of Phys., Tsinghua Univ., Beijing), Feng S. Bu (Beijing General Res. Inst. for Non-Ferrous Metals, Beijing, China), "`Excess Heat' Measurement in Gas-Loading (D/Pd) System," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 65.

AUTHORS' ABSTRACT

The "heat after death" has revealed a fact that the electrolysis is not necessary for "excess heat" phenomena. Provided that enough deuterons are filled in the palladium crystal lattice, we may expect to see the "excess heat" in a gas-loading system also. The Italian, Indian, and American scientists have succeeded in loading the deuterium gas into the palladium sample with loading ratio (D/Pd) greater than 0.80 under the pressure less than 1 atm. This facilitates the quantitative observation of the "excess heat" in a gas-loading system. Besides, the gas-loading system has showed high reproducibility in loading, and has the advantage to be operated at high temperature which means a higher efficiency as an energy device; hence, a series of gas-loading experiments have been conducted to observe the "excess heat" in a gas-loading system.

The observation of the "excess heat" would be presented in a system with the following 4 features:

(1) Heat treatment of the palladium surface in a closed system which allows the annealing in vacuum or in deuterium (hydrogen) gas with the capability of controlling the temperature precisely. Particularly, the palladium surface would not be

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exposed to the air (oxygen) before the "excess heat" measurement.

(2) Monitoring the loading ratio in situ, with both the volumetric method and the electrical resistance method. Then the correlation between the "excess heat" and the loading ratio would be monitored.

(3) Measuring the "excess heat" with an accuracy of 0.2 W in a long period (days to a month). Since the volume of the palladium wire is about 0.2 c.c., we are supposed to see the "excess heat" if its power level is above 1 W per c.c. palladium.

(4) Accumulating the nuclear products (if any) in a closed stainless steel vessel. Helium-3, helium-4, and tritium are supposed to be checked first after the long run using mass-spectrometric method and nuclear method.

A pair of "twin system" have been run in parallel with deuterium gas and hydrogen gas using "twin palladium samples." "Twin samples" means that they were cut from the same roll of the palladium wire; cleaned, heated and cooled under the same condition. In fact they were born as a pair of "twin."

The preliminary runs have shown distinct contrast between these "twin samples", which may be explained as an evidence of "excess heat" in D/Pd system. A series of runs are expected before the ICCF-6.

Chang B. Liu and Guo Z. Wang (Beijing Yuan Heng Physicochemical High Scientific and Technical Corp., Beijing, China), Jie Wang (Inst. of Geology, Academia Sinica), Xi Y. Li (Inst. of Semiconductor, Academia, Sinica), Da W. Mo (Inst. of Nuclear Energy, Tsinghua Univ.), Xing Z. Li (Dept. of Phys., Tsinghua Univ., Beijing, China), "Preliminary Study on Tritium and Elements Transmutation in Water Under Simulated Aerospatial Conditions," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 154.

AUTHORS' ABSTRACT

Reifenschweiler's work on the tritium decay showed that the nuclear radiation might change due to the variation of the environment. On the other hand, a series of unexpected phenomena have been discovered in the aerospatial conditions in terms of the spaceships. An attempt has been started to mimic the aerospatial conditions as that in the F-2 ionsphere (vacuum, ionization, weightless. etc.) in the laboratory on the earth. The tritium was added into the light water, and let this tritium-rich water pass through this aerospatial condition. The beta-radiation of tritium was measured before and after this process in terms of liquid scintillation technique. It was found that the radiation from tritium decreased every time it passed through this aerospatial condition (see table A).

Table A

SampleNo .	Beforeprocessing Bq.lml	Processingonce Bq.iml	Processing twice Bq.mi
1	1.2	0.9	0.8
2	1.2	1.0	0.6
3	1.2	0.7	0.5
4	1.2	0.9	0.8

The trace elements were analyzed for the distilled water before and after the same process. It was found also that the change of the trace element is more than the sensitivity of the technique (atomic absorption spectrum method), which can be seen in the table B.

Table B

Element	K	Na	Ca	Mg	Zn
Processing:					
before	0.0045	0.098	0.04	0.006	0.0145
after	0.008	0.165	0.663	0.018	0.006

UNITED STATES

T.A. Chubb and S.R. Chubb (Oakton International Corp.), "Radiationless Cold Fusion: Why Small `Crystals' are Better, N_{cell} Requirement, and Energy Transfer to Lattice," ICCF-6, October 13-18,1996, Hokkaido, Japan, *Program & Abstracts*, pg 60.

AUTHORS' ABSTRACT

Arata and Zhang have shown that Pd powder generates dd-fusion heat and commensurate ^{4}He nuclear product. Evidently higher power density can be achieved using small "crystal" Pd than with conventional metal, since the D_2 pressure in contact with Arata's Pd powder corresponds to a lower D chemical potential than that used in Fleischmann and Pons electrolysis. This behavior is consistent with D^+ ion band state theory, in which the active ingredient is Bloch function D^+_{Bloch}, described by an initial stationary-state, many-body wave function having the symmetry of the lattice and describing a coherent fractional occupation of each unit cell of a host crystal.

The small crystal effect results from the fact that the reaction rate equation depends on the "field" strengths of both the initial and final states. Time-dependent perturbation theory is microscopically reversible. Matter "field" reactions are

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stimulated reactions like the laser reaction. Both initial state "field" strength $[C_{D,Bloch}{}^2\ \pi' g(r_{ij})^2]/2$ and final state "field" strength $C_{He^*,Bloch}$ contribute with equal weight to the reaction rate. Here, each $g(r_{ij})$ is a dimming function which decreases the initial state "field" strength as particle pair separation $r_{ij} \rightarrow 0$. The number of initial state excited nuclei $N_{He^*,initial}$ is always zero since de-excitation of the nuclear state He^* is part of the completed preceding reaction. The final state $N_{He^*,final}$ in the crystal is always $(N_{He^*,initial} + 1) = 1$. Hence, the final state concentration per unit cell $C_{He^*,Bloch,final} = 1/N_{cell}$. Therefore, the volumetric reaction rate $n \propto 1/N_{cell}$, favoring small-crystal structures.

Ion band state D^+ requires a minimum value of N_{cell} for non-zero wave function overlap and consequent nuclear reactivity. This minimum value depends on a dimensionless Mass-Ratio-Screening Number $\boldsymbol{S} \equiv (m_D m_e)\ (r_{sc}\alpha_O)$ were m_D and m_e are the deuteron and electron masses, and r_{sc} and α_O are the electron screening radius and the Bohr radius. This change from chemistry-type behavior to many-body physics behavior is discussed elsewhere.

For quantum fluctuations to become reactions, de-excitation of the final state must occur. The nuclear fluctuation changes the quantum of mass from mass 2, charge 1 → mass 4, charge 2, which causes an 8x decrease in associated zero-point-motion volume. This shrinkage of positive charge directly couples to the neutralizing distributed negative charge through a shift of the electron fermi energy relative to the D and ^4He chemical potentials. The resulting shift causes a uniform, discrete change in the volume in each unit cell except at the boundaries, where local charge neutrality is lost. For embedded crystals the electron Fermi sea extends across grain boundaries and across the scattering centers where imperfect periodic order and thermal fluctuations are the sources of electrical resistivity in metals. When the electron distribution is perturbed, Bloch-function electrons are excited into higher energy states at the scattering sites, making the nuclear fluctuation irreversible. At the metal surface, the negative charge density extends beyond the positive charge density, creating a plus → minus dipole layer on the surface. Disturbance of the surface dipole layer excites surface states and generates phonons. Crystal shrinkage causes compression-dilation oscillations about a final state lattice of reduced size.

T.N. Claytor, M.J. Schwab and D.G. Tuggle (Los Alamos National Lab., NM), "Analysis of Reaction Products from a CETI Cell," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 44.

AUTHORS' ABSTRACT

Over the past few months we have been examining the light water CETI electrolytic cold fusion cell. The cell uses a lithium sulfate (Li_2SO_4) electrolyte and special, multilayer, Pd-Ni plated beads. During cell operation, we have taken calibrated temperature measurements on the inlet and outlet of the cell in order to determine if a particular run shows signs of heat production. If the cell appears to be active, we allow it to run for several days to a week, remove the beads, and analyze them to look for possible nuclear products. Since, the beads may have some impurities, the analysis will include calibration with unused beads from the same batches. The techniques used to analyze the beads will include x-ray fluorescence and high sensitivity gamma counting. Given the opportunity, these results will be compared with results from SEM and Neutron Activation measurements taken independently at the University of Illinois.

T.N. Claytor, M.J. Schwab and D.G. TuggIe (Los Alamos Natl. Lab., NM), "Tritium Production from Palladium and Palladium Alloys," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 53.

AUTHORS' ABSTRACT

A number (22) of pure palladium samples and palladium alloys have been loaded with a deuterium or hydrogen plasma in a system that allows the instantaneous measurement of tritium. By carefully controlling the high pressure plasma conditions, the plasma can be constrained to only contact palladium surfaces and to only lightly sputter the palladium. Long run times (up to 200 h) result in an integration of the tritium and this, coupled with the high intrinsic sensitivity of the system(~ 0.1nCi/l), enables the significance of the tritium measurement to be many sigma (> 10). In addition to the real time tritium measurement, the deuterium gas can be combined with oxygen, at the end of a run, resulting in water samples that were counted in a scintillation counter. The results of these confirmatory measurements of the tritium in these water samples agree quantitatively with the decrease in tritium as measured by the ion sensor. However, surprising concentrations (up to 1.5×10^6 dpm/ml) of tritium were found in several samples that had been exposed to a hydride inhibitor. We have continued to investigate the effect of hydrogen additions on the output of tritium in these types of experiments and find that hydrogen additions always suppress tritium production.

We will show the difference in tritium generation rates between batches of annealed palladium, as received palladium and the palladium alloys (Rh, Co, Cu, Ni, Be, B, Li, Hf, Hg and Fe) of various concentrations to illustrate that tritium generation rate can vary greatly from alloy to alloy as well as within a specific

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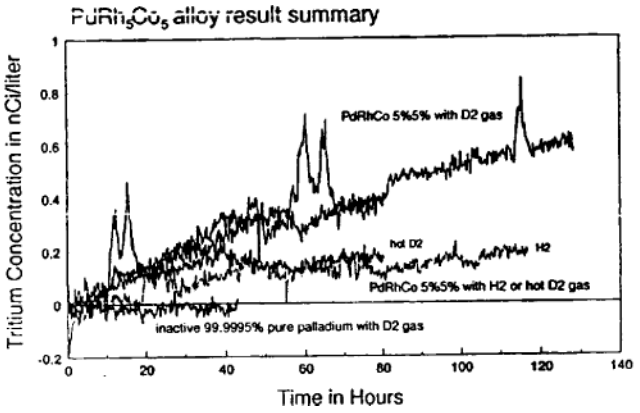
alloy, dependent on concentration. Other metals (Pt, Hf, Ni, Nb, Ta, V, W, Zr) have also been run in the system as background samples or to determine if tritium could be detected in the gas analysis system. In nearly all cases they have produced results very close to background drift rates.



Dennis Cravens, Mike Posey (Clean Energy Technologies, Inc.), "Electrical Control of New Hydrogen Energy Reactions," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 39.

AUTHORS' ABSTRACT

Heat is produced from the electrochemical loading of natural hydrogen into metals. This has often been difficult to reproduce in some systems. The Patterson Power Cell™ has produced excess heat at levels and consistencies that have allowed for systematic studies of the heat generation under a range of electrical inputs. The use of pulsed currents allow for a range of electrochemical effects. These allow for avoidance of some difficulties encountered at the anode. The modification of the current from the standard constant current approaches allows for initiation and control of the heat generating reactions. In cases of "life after death" the duty cycles can be matched to the required heat output to decrease the integrated electrical energy applied to the cell and therefore increase power gain ratios.

P.L. Hagans, E.F. Skelton, D.D. Dominguez, S.B. Qadri and D.J. Nagel (Naval Res. Lab., Washington, D.C.), "In Situ Determination of Structural Changes Accompanying the Electrochemical Absorption of Deuterium in Pd Using Synchrotronwiggler Radiation," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 50.

AUTHORS' ABSTRACT

Structural changes induced by the absorption of deuterium into a Pd lattice were monitored with X-ray diffraction measurements conducted on the super-conducting wiggler beam line, X-17C, at the National Synchrotron Light Source at Brookhaven National Laboratory. Absorption of deuteride was accomplished electrochemically in a 1 cm by 1 cm polyethylene cell containing 0.1M LiOD in D_2O as the electrolyte and a 1 mm diameter by 3 cm long Pd wire as the cathode surrounded by a 0.254 mm thick graphite foil anode. The anode and cell materials were selected so as to be transparent to X-rays. The enhanced beam brilliance obtained on a wiggler line allowed Pd diffraction spectra to be obtained in-situ during electrolysis. In addition the focused beam (approximately 28 μm in diameter in this experiment) allowed diffraction spectra to be acquired as a function of distance across the sample. For these measurements spectra were recorded from the surface and at 100 μm intervals until the center of the Pd wire was reached. Spectra were obtained in 2 minute intervals as a function of time of electrolysis and current density. Comparison of the lattice volume change as a function of time due to D absorption at the edge and the center of the Pd wire as calculated from the Pd-(422) diffraction peaks from both Pd and α- and ß-phase Pd-H indicate that the transition from the mixed α + ß Pd-H phases to the pure ß-phase occurs at the same time. In addition, although the α-phase forms very rapidly on both the surface and the core, initiation of ß-phase formation is delayed 35 mins. in the core over that on the surface. The α-phase does persist in the core approximately 30% longer in the core than on the surface. Small increases in the pure ß-phase lattice parameter at the edge are observed when the current density is increased. New data just acquired will correlate bulk resistance measurements with Pd lattice volume changes as a function of distance across the cathode. These data represent the first time that the Pd lattice expansion has been measured in an electrochemical cell with a cylindrical cathode as a function of distance across the cathode.

Patrick L. Hagans, Dawn D. Dominguez and M. Ashraf Imam (Naval Res. Lab., Washington, D.C.), "Surface Composition of Pd Cathodes," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 110.

AUTHORS' ABSTRACT

Impurities on the cathode surface are expected to exert an influence on the ability of cathodes to attain D(H)/Pd ratios near unity and to retain this high loading for the time required to obtain excess heat. Results will be presented for the surface analyses of cathodes before and after using X-ray Photoelectron Spectroscopy (XPS). XPS data will include composition as a function of depth employing argon ion sputtering to gradually

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erode away the surface. Although most of the emphasis will be on Naval Research Laboratory (NRL) Pd (i.e., Johnson Matthey high purity sponge processed into rod at NRL), data from other Pd sources and excess heat-producing cathodes from two other laboratories, SRI International and NAWC (Naval Air Warfare Center), will also be presented. XPS results will be compared with bulk sample cathode and anode analyses obtained by Glow Discharge Mass Spectroscopy (GDMS) and with electrolyte solution analyses obtained by Inductively Coupled Plasma (ICP).

Unused cathodes were all found to contain a thin layer of C and O contamination which could easily removed after a few seconds of ion sputtering. Pd was always visible by XPS on the unsputtered surface. **In contrast, used cathodes often were covered with very thick (>100 nm) overlayers containing as many as 10 different elements. Pd was almost never observed on unsputtered surface indicating that at long electrolysis times the Pd cathodes are completely covered by an impurity layer which controls D_2O reduction and D_2 dissociation and the absorption and, desorption of D into and out of the Pd lattice.** For NRL cathodes impurity layer thickness was dependent on time of electrolysis. A direct correlation between composition and maximum D/Pd was observed. Similar impurity overlayers were also found on excess heat-producing cathodes but the concentrations were generally different than that observed on NRL cathodes. In examples where no chemical additions (for the purpose of sustaining heat production) were made to the relatively thin layers, as judged by when Pd was first detected in the depth profile, were observed. Extremely thick layers were observed on cathodes where additions to the electrolyte were made. Speculation as to the influence of these impurities on loading and the source of the impurities will be presented.

Yeong E. Kim and Alexander L. Zubarev (Dept. of Phys., Purdue Univ., West Lafayette, IN), "Optical Theorem Formulation and Gamow Factor Cancellation for Low- Energy Nuclear Reactions," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 55.

AUTHORS' ABSTRACT

In our recent paper, we showed that a Gamow factor cancellation (GFC) can occur for nuclear fusion reactions if the imaginary part of the effective nuclear interaction in the elastic channel (ENIEC) has a small component of a finite long-range interaction (FLRI), but we could not prove nor rule out theoretically the existence of such a FLRI component in the imaginary part of ENIEC. In another recent paper, we demonstrated (without a rigorous derivation) a possibility of the existence of FLRI components if the target nucleus has a weakly bound excited state ("halo" nuclear state). Most recently, we have succeeded to derive rigorously a new type of FLRI interaction in the imaginary part of ENIEC for the case in which one of the final-state nuclei has an excited halo nuclear state. We have obtained a separable form factor for the imaginary part of ENIEC which at large distances behaves as $\cos(k_o r - \eta \ln 2k_o r + \delta)\varphi_n(r)/r^4$, where k_o, η, and $\varphi_n(r)$ are the final state wave number, the Sommerfeld parameter, the phase shift, and the wave function for the excited p-wave halo nuclear state, respectively. Consequences and implications of our results for the cold fusion phenomena are described.

M.C.H. McKubre, S. Crouch-Baker and F.L. Tanzella (SRI International, Menlo Park, CA), "New Hydrogen Energy Research at SRI International," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 35.

AUTHORS' ABSTRACT

With financial support from the Institute for Applied Energy (IAE), SRI International has undertaken a research and development program in the field of New Hydrogen Energy production. The long-term goals of this program are (i) to understand the phenomenology and identify the mechanism(s) of new hydrogen energy production, and (ii) to increase the rate of energy production to useful levels. To these ends, in addition to research at SRI International, collaborative research with IAE has been undertaken at SRI and IAE's facility in Sapporo.

Research has been undertaken in a number of areas: Firstly, calorimetric studies of the palladium/heavy water system have been carried out using electrochemical cells housed in well-qualified mass flow calorimeters, one design of which is capable of accurate measurement of the helium content of the cell. Although most results have been obtained for electrolyte temperatures in the range 25-40° C, some experiments have been undertaken in the vicinity of the boiling point of heavy water. In addition to these calorimetric experiments, extensive studies have been made of the electrochemical loading of deuterium into palladium obtained from a variety of sources.

Results will be presented of various experiments intended to test the conditions necessary for excess power production: as described by SRI researchers in previous presentations and publications, and as described by Fleischmann and Pons at and near the electrolyte boiling temperature. While the results obtained are consistent with those obtained previously, by various researchers, it is clear that attainment of the necessary conditions for excess heat production is greatly impeded by a materials-induced variability of a critical parameter which is not presently under our control.

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M.C.H. McKubre, S. Crouch-Baker and F.L. Tanzella (SRI International, Menlo Park, CA), D. Cravens (CETI, New Mexico), "Electrochemistry and Calorimetry in a Packed-Bed Flow-Through Electrochemical Cell," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 42.

AUTHORS' ABSTRACT

Packed bed electrochemical cells have come to recent prominence as a convenient way to provide a large area cathode (of nickel and/or palladium) in the search for "excess heat" production. In such cells, the electrolyte is constrained to flow axially, parallel to the direction of net current flow. Calorimetry can be performed by measuring the mass flow rate and temperature rise of the electrolyte in its transit through the cell.

This paper focuses on aspects of electrochemistry, electrochemical engineering and calorimetry that are peculiar to flow-through packed-bed cells. Results will be presented of measurements and calculations intended to characterize the distribution of electrochemical process: current, potential and composition, within the heterogeneous structure of the packed bed cathode. The interpenetrating, continuous conductive elements formed by the solid phase (coating) metallic conductor and the pore-filling electrolyte phase, extended in the dimension of current flow, form a system which can be modeled as an electrochemical transmission line. The results of such modeling can be used to predict the depth of electrochemical activity within a packed bed, and to estimate the profile of hydrogen (deuterium) activity.

The presence of gas bubbles, evolved in the pores of the cathode, and convected to and through the anode, introduce interesting complications. Depolarization of the anode may occur by the oxidation of dissolved hydrogen, giving the appearance of (partial) recombination. Also, the mixed phase flow of (near) stoichiometric electrolysis gas and electrolyte, makes accurate temperature measurement more difficult. Experience gained in operating such calorimeters will be described, together with the results of modeling calculations.

Melvin H. Miles and Kendall B. Johnson (Chem. & Mat. Branch, R. & Tech. Div., Naval Air Warfare Center Weapons Div., China Lake, CA), M. Ashraf Imam (Physical Metallurgy Branch, Mat. Sci. and Tech. Div., Naval Res. Lab., Washington, DC), "Heat and Helium Measurements using Palladium and Palladium Alloys in Heavy Water," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 28.

AUTHORS' ABSTRACT

Our best experiments produced up to 30% excess heat, 0.52 watts of excess power, and 1,400 KJ of excess enthalpy. This amount of excess enthalpy is difficult to explain by any chemical reaction. We have demonstrated that any recombination of the D_2 and O_2 electrolysis gases in our experiments can be readily detected and easily corrected. There was never any measurable recombination when the palladium cathodes were fully submerged in the D_2O-LiOD electrolyte.

Our studies provide overwhelming evidence that the anomalous effects in deuterated systems are real. Nevertheless, we have not been able to solve the reproducibility problem. This research area will remain highly controversial until reproducibility can be demonstrated. The lack of reproducibility stems mainly from an unknown and uncontrolled variable contained within the palladium stock. There is a remarkable correlation of excess power with the source of the palladium. The best reproducibility was obtained using Pd-B materials supplied by the Naval Research Laboratory. Seven out of eight experiments that used Pd-B cathodes produced excess power. A high success ratio was also obtained using Johnson-Matthey materials. Seventeen out of twenty-seven experiments that used this palladium source produced excess heat. In contrast there were several palladium sources that never produced excess power in any experiment. Our calorimetric results and problems are practically identical to those reported by the SRI laboratory. They are also consistent with many other laboratories that have reported excess heat. Calorimeters that are capable of detecting excess power levels of 1 watt per cubic centimeter of palladium are essential for research in this field. The small volume of palladium in co-deposition experiments is likely the reason why it was difficult to detect excess power effects in such studies.

Our results indicate that helium-4 is the missing nuclear product. Thirty experiments have shown a correlation between either excess power and helium production or no excess power and no excess helium. Studies using both glass and metal flasks place the ^4He production rate at 10^{11} to 10^{12} atoms/s per watt of excess power. This is the correct magnitude for typical fusion reactions that yield helium as a product. It is highly unlikely that our heat and helium correlations could be due to random errors. The only valid experiments that showed significant excess power but no excess helium involved a Pd-Ce cathode. The odds are less than one in a million that our complete set of thirty-three heat and helium results could be obtained from random experimental errors.

G.H. Miley, G. Narne, M.J. Williams (Fusion Studies Laboratory, Univ. Ill, Urbana, IL), J.A. Patterson, J. Nix, D. Cravens (CETI, Dallas, TX) and H. Hora (Univ. New So. Wales, Australia), "Design Considerations for Multilayer Thin-Film Patterson-Type Microspheres," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 40.

AUTHORS' ABSTRACT

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As described in a companion paper, multilayer thin-film electrodes employing various numbers of Ni/Pd layers and single layers of Ni or Pd on 1-mm cross-linked polymer microspheres have produced intense proton-metal transmutations. These results are consistent with the earlier "swimming electron layer" (SEL) theory and with prior studies of thin-film flat-plate electrodes. Following this earlier work, the selection of thin-film metal pairs is based on four parameters: maximum Fermi energy level difference, good hydrogen/deuterium (H/D) diffusivity, good H/D solubility, and minimum interdiffusion coefficients. Experiments to date have concentrated on 300-800-Å-thick films of Pd/Ni and Pd/Ti, giving Fermi level differences (ΔF) of 1.5 and 1.7 respectively. These combinations were selected on the basis of ready availability of materials and ease of manufacturing, but other combinations potentially offer more intense reaction rates. Examples include Ce/Be, Pd/Zr, Th/Pt, and Th/Be, with ΔF = 7.4, 1.6, 2.4, and 5.5 ev, respectively. Extensive studies of surfaces and interfaces of the multilayer films before and after use in an electrolytic cell have been carried out, using Auger electron probe and scanning electron microscopy. Results from these studies will be presented.

G.H. Miley, G. Narne, M.J. Williams (Fusion Studies Lab., Univ. of Illinois, Urbana), J.A. Patterson, J. Nix, D. Cravens (CETI, Dallas, TX), and H. Hora (Univ. New So. Wales, Australia), "Experimental Observation of Massive Transmutations Occurring in Multilayer Thin-Film Microspheres After Electrolysis," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 41.

AUTHORS' ABSTRACT

Over a dozen experiments have been carried out using multilayer thin-film microspheres, designed on the basis of "swimming electron layer" (SEL) theory using a 1-molar lithium sulfate light water electrolyte in a flowing packed-bed electrolytic Patterson-type cell. **Significant quantities of transmutation products have been obtained in all of these runs, which have lasted periods ranging from one to five weeks. Transmutation of the metallic coatings to new reaction with yields exceeding 50% of the initial metal weight, have been obtained in some cases.** Excess heat is also observed in these runs, but varies greatly, depending on the configuration.

The largest yields have been obtained for Cu, Al, and Ag, although a variety of additional products are observed, using a combination of secondary ion mass spectrometry (SIMS) analysis and neutron activation analysis (NAA). The dominant product varies depending on the specific coatings employed, with the largest yields typically coming from single-layer Pd or Ni on cross-linked polymer microspheres or from multilayer Ni-Pd-Ni-Pd-Ni microspheres. While the yields are so large as to the possibility of impurity artifacts, some special runs have been carried out and a unique "clean" cell, where the only metal present, in addition to the microspheres, were the Ti or Pt electrodes.

Both heavy and light products, with atomic numbers considerably above and below that of the base metal (Ni or Pd), are observed. This can only be explained by proton-induced transmutations, followed by a fission of the heavier-mass product. The resulting process is quite unique and has been termed "fusfiss."

Detailed results and the reaction product analyses will be presented, along with a discussion of the fusfiss mechanism.

R.A. Oriani (Corrosion Res. Cntr., Dept. of Chem. Eng. & Matls. Sci., Univ. of MN), "A Confirmation of Anomalous Thermal Power Generation from a Proton-Conducting Oxide," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 58.

AUTHOR'S ABSTRACT

The claims of Mizuno and collaborators, and the earlier claims of Biberian and Forrat, that excess thermal power can be developed by proton-conducting oxides held in deuterium gas at elevated temperatures are important because thermal power generated at high temperatures can be converted to other forms of power with greater Carnot efficiency than thermal power at lower temperatures. Therefore a Seebeck calorimeter operating at 400° C was constructed to attempt to verify these claims. This calorimeter, whose operation is independent of the spatial distribution of power sources and of the thermal conductivity of the gas, is described.

The calorimeter was used with specimens of nominal composition $SrCe_{0.9}Y_{0.08}Nb_{0.02}O_{2.97}$ supplied by Dr. T. Mizuno. Two of these specimens produced positive deviations from the calibration curve by more than four standard deviations so that thermal power was produced that was greater than the D.C. power of alternating polarity supplied to the specimen. In several episodes excess power was produced without supplying any D.C. power.

Verification of the claims has been achieved. It remains to increase the reproducibility and the power output of the technique, as well as to achieve understanding of the underlying mechanism of the phenomenon.

Thomas O. Passell (Electric Power Research Inst., Palo Alto, CA), "Search for Nuclear Reaction Products in Heat Producing

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Pd," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 57.

AUTHOR'S ABSTRACT

EPRI has sponsored several research projects to check the claims of cold fusion made in the 1989 announcement of Pons and Fleischmann. The evidence obtained indicates that the claimed amounts of excess heat in highly deuterated palladium are indeed present under conditions difficult to achieve but successful in some 30 to 50% of the serious attempts. While the excess heat appears confirmed, the source of the heat is unclear. By inference it must be from some reaction with at least ten times chemical reaction heat outputs per atom present, well above 200 electron volts per atom. The only known reactions in this category are ones involving the nucleus. The few observations of normal products of nuclear reactions such as neutrons, tritium, radioactive isotopes, and gamma rays have been rare and always at intensities from 6 to 12 orders of magnitude below the levels needed to explain the observed watt-level excess powers. HOWEVER, these observations are at least 40 orders of magnitude above expectations from current nuclear reaction theory. Recent efforts to find the source of the excess heat have focussed upon measuring changes of ratios of stable isotopes in palladium cathodes that have produced the larger amounts of total integrated excess heat over their time in the electrochemical cells. Such changes might be expected if the roughly commensurate helium-4 observations are assumed to be one of the products of the nuclear heat-producing reaction. Results from several such cathodes from various sources will be shown. The analytical method used for this measurement of isotopic ratios is prompt gamma neutron activation analysis in the thermal neutron beam exiting from a research reactor. Preliminary results from the first such attempt using this method on the cathode from the SRI cell known as C-2 indicate the possibility that the boron-10 impurity may be depleted relative to the amount present in the virgin material from the same batch of Pd foil. This result must be confirmed by many more analyses on the same and other cathode materials.

James Patterson, John Nix, Dennis Cravens (Clean Energy Technologies, USA), George Miley, Gokul Narne, Michael Williams (Univ. Illinois, Urbana), "Producing Excess Enthalpy and Nuclear Reaction Products in the Patterson Power Cell™ with Near 100% Reproducibility," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 43.

AUTHORS' ABSTRACT

Experiments with the Patterson Power Cell™ consistently demonstrate heat output 1000% above electrical power input, and the phenomena has been repeated in several independent laboratories. The unparalleled reproducibility in both heat production and nuclear reaction products provide an essential basis for developing a theoretical understanding of the phenomena.

We have developed a detailed test protocol for cell operation to precisely quantify the heat generation and correlate excess enthalpy with nuclear products. With a Patterson Power Cell™ and relatively inexpensive laboratory equipment, proper implementation of the protocol can detect heat output with a resolution of 20 milliwatts. Since the typical excess power observed is one watt, the test protocol provides resolution of one part per 50.

In this paper we review our initial results from implementing the protocol. Issues addressed include thermal measurement technique, bead packing and sampling, electrolyte composition, loading the metal with hydrogen, and cell operation. We quantify the progression of the nuclear reaction over time and correlate heat production with nuclear ash.

E. Storms (ENECO, NM), "Some Thoughts on the Nature of the Nuclear-Active Regions in Palladium," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 38.

AUTHOR'S ABSTRACT

The accumulated experimental knowledge about the CF effect allow a number of general conclusions to be drawn. Such conclusions need to be considered by any theoretical approach and applied to any effort to improve the scale of the effect. The following conclusions will be proposed and defended:

1. The anomalous reactions occur only in special, small, isolated regions within the host material.

2. The distribution of these regions is random because a combination of many local conditions is required for their creation.

3. Any theory based only on the properties of the host material will have limited application.

4. Any effort to improve the scale of the effect by modifying the gross properties of host material will produce poor success.

Experimental results describing a pretest method for identifying energy-producing palladium and the location of the active sites will be described.

F.L. Tanzella, S. Crouch-Baker and M.C.H. McKubre (SRI International, Menlo Park, CA), A. McKeown (Visiting Scientist, Univ. of Strathclyde, Glasgow, Scotland), "Parameters

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Affecting the Loading of Hydrogen Isotopes into Palladium Cathodes," ICCF-6, October 13-18, 1996, Hokkaido, Japan, *Program & Abstracts*, pg 48.

AUTHORS' ABSTRACT

One of the important criteria necessary for the production of excess power in deuterated palladium is the attainment of a high deuterium loading (i.e. D/Pd > 0.9). We have also found it necessary to maintain this high loading condition while applying high (>300m A/cm_2) cathodic current densities in order to yield excess power. Many parameters affect the attainment of this high (low current density) loading condition and a cathode's ability to maintain this condition during the application of high currents. We have examined some of the important and accessible parameters related to obtaining high loading. These are: Pd source and casting procedure, cathode size and shape, presence of ionic additives, presence of potential contaminants, and cathode preparation procedure.

We have also examined the effect of different operational parameters, such as the application of cathode axial currents and in-situ surface cleaning. In response to reports of the use of thermodynamic reference potentials to predict a Pd cathode's ability to produce excess power, we have initiated a study of methods to measure such potentials in our electrochemical cells. We have attempted to correlate this measured potential with our Pd resistance/ratio measurement (used to estimate the average, bulk loading, D:Pd), as well as the true thermodynamic reference potential of the Pd cathode

Our results show that two lots of Pd cathodes, supplied by IMRA Material R+D Co., Inc., (I/M), and a special low Pt-group-metal Pd from Johnson-Matthey (J/M), loaded better under our present experimental conditions that recent lots of Pd from Engelhard. Furthermore, the I/M Pd lot cast in air, with CaB_6 added, displayed different loading characteristics than that for the I/M lot that was vacuum-cast with no additives. Earlier results show that the Engelhard Pd rods can load to reasonably high values if we machine the surface, anneal, and etch the surface in acid directly before commencing electrolysis. We examined the effect of annealing and acid-etch treatments of the I/M and J/M cathodes immediately before use.

When testing chemical additives, we observed a temporary, beneficial effect, from the addition of ions to cathodes which otherwise yielded poor loading. Addition of Al is almost never harmful and usually yields higher maximum D:Pd ratios. The composition of the anode lead wires does not affect the loading performance of the cathodes that we tested. Silicon, which is always present in our cell construction, is probably important to yield good loading.

We have examined a small set of parameters that affect the D loading of Pd cathodes and determined a few which are either essential or beneficial to good initial loading. Although we have identified a few parameters beneficial to achieving higher loadings, we have only rarely maintained that high initial loading at higher current densities. We are examining other methods (lower temperatures, in-situ surface cleaning, axial currents, etc.) in an attempt to maintain these loadings. We will report the results of these latter experiments in this and other presentations at this conference.

C. COMMERCIAL COLUMN

The following companies (listed alphabetically) are commercializing cold fusion or other enhanced energy devices:

COMPANY: PRODUCT

American Pure Fusion Engineering and Supply: Information and troubleshooting for the fusion research and development industry. Developing "Fullerene Fusion Fuel™." Salem, Oregon. The president, Warren Cooley, can be reached at 1-800-789-7109 or 503-585-6746. Email to: Coolwar@aol.com

CETI (Clean Energy Technologies, Inc.): Developers of the Patterson Power Cell™. Dallas, Texas. Voice 214-982-8340, FAX 214-982-8349.

Clustron Sciences Corp.: New energy research consulting and information. Contact: Ron Brightsen, 703-476-8731.

ENECO: Portfolio of intellectual property including over thirty patents issued or pending in cold nuclear fusion and other enhanced energy devices. Salt Lake City, Utah. Contact Fred Jaeger, Voice 801-583-2000, Fax 801-583-6245.

E-Quest Sciences: Exploring The Micro-Fusion™ process. Seeking qualified research partners for their sonoluminesence program. Contact Russ George, FAX 415-851-8489.

Fusion Information Center (FIC): Research and development of new energy systems. The world's most complete resource depository for cold fusion research information, as well as other new energy research including zero-point energy; space energy research; electronic, electromagnetic, and mechanical over unity devices and more. We are the publishers for *Fusion Facts, New Energy News*, and *the Journal of New Energy*. Voice 801-583-6232, Fax 801-583-2963.

Holotec AG, Clean Energy Technology, contact André Waser, Gen. Mgr., Bireggstrasse 14, CH-6003, Luzern, Switzerland. Phone 011 41-41 360 4485, or Fax 011 41-41 360 4486.

Hydro Dynamics, Inc.: Hydrosonic Pump, heat-producing systems using electrical input with thermal efficiencies of 110 to 125 percent.

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Rome, Georgia. Contact James Griggs, Voice 706-234-4111 Fax 706-234-0702.

International Management Systems Co. (IMSC): Technical project/program management assistance, and technology development and commercialization assistance. Contact Mark Harris or Richard Youngs, Phone 801-583-6232, Fax 801-583-2963, or Phone/Fax 801-255-3000.

JET Energy Technology, Inc.: Design and manufacture of π-electrode systems, calorimeters, and associated equipment and systems. Consulting regarding radiation, materials, and other scientific and engineering issues. Weston, MA. Contact Dr. Mitchell Swartz, Voice 617-237-3625. Fax 617-237-3625.

Labofex, Experimental and Applied Plasma Physics: R&D of PAGD (Pulsed Abnormal Glow Discharge) plasma technology. Applications under development include portable power supplies, electric vehicles and autonomous housing. Licensing. Ontario, Canada. Contact Dr. Paulo N. Correa. Tel 905-660-1040
Fax 905-738-8427

Magnetic Power Inc.: The Joint Venture partner with Sciex (UK) for Takahashi supermagnets and supermotors in North America. Sebastopol, CA. Contact Mark Goldes, Voice 707-829-9391, Fax 707-829-1002.

Nova Resources Group, Inc.: Design and manufacture ETC (Electrolytic Thermal Cell); EG (commercial power cogeneration module); and IE (integrated electrolytic system). Denver, CO. Call Chip Ransford, Phone 303-433-5582.

UV Enhanced Ultrasound: Cold Fusion Principle being used for an ultrasonic water purifier. Hong Kong. FAX 852-2338-3057.

Zenergy Corporation: Founded in 1996 to facilitate the introduction of commercially viable energy alternatives. Chandler, AZ. Contact Reed Huish: 602-814-7865, Fax 602-814-7665, e-mail: reedh@indirect.com

Note: The Fusion Information Center has been acting as an information source to many of these companies. We expect to augment our international service to provide contacts, information, and business opportunities to companies considering an entry into the enhanced energy market.

INFORMATION SOURCES

Academy for New Energy (ANE) is a subsidiary organization to the International Association for New Science, which has specific goals directed toward the field of alternative and "New" energy research. 1304 S. College Ave., Fort Collins, CO 80524. Tel. 970-482-3731

ANE Newsletter, quarterly publication of ANE, providing an open forum for discussion, and disseminating newsworthy and inspirational information on invention and new energy. Edited by Robert Emmerich.

Advanced Energy Network Newsletter, quarterly, a reprint of articles and papers from other energy publications, with book reviews and worldwide conference list. Advanced Energy Network, P.O. Box 691, Rondebosch 7700 Capetown, Rep. South Africa.

Cold Fusion, monthly newsletter, edited by Wayne Green, 70 Route 202N, Petersborough, NH 03458.

Cold Fusion Times, quarterly newsletter published by Dr. Mitchell Swartz, P.O. Box 81135, Wellesley Hills MA 02181. Home Page: http://world.std.com/~mica/cft.html

Cycles, a R&D newsletter, published by Dieter Soegemeier, Editor, GPO Box 269, Brisbane, QLD.4001, Australia. Phone/Fax: +61 (0)7 3809 3257.

Electric Spacecraft Journal, quarterly, edited by Charles A. Yost, 73 Sunlight Drive, Leicester, NC 28748.

Electrifying Times, 3 issues per year, published by Bruce Meland, 63600 Deschutes Road, Bend, OR 97701, Phone (503) 388-1908, FAX (503) 382-0384, E-MAIL 102331.2166@compuserve.com.

***Fusion Facts* monthly newsletter. Salt Lake City, UT. 801-583-6232, also publishes Cold Fusion Impact and Cold Fusion Source Book. Plans on-line database access.**

Fusion Technology, Journal of the American Nuclear Society, edited by Dr. George Miley, publishes some papers on cold nuclear fusion. 555 N. Kensington Ave., La Grange Park, IL 60525.

Infinite Energy, new bi-monthly newsletter edited by Dr. Eugene Mallove (author of **Fire from Ice**), P.O. Box 2816, Concord, NH 03302-2816. Voice: 603-228-4516.
Fax: 603-224-5975
E-mail 76570.2270@compuserve.com

Institute for New Energy (INE), organization to promote and help find funding for new energy research.
Home Page: www.padrak.com/ine/ contains many important scientific papers and current reports on all areas of research.
E-mail: ine@padrak.com Salt Lake City, Utah.
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***New Energy News* monthly newsletter for INE, highlighting the research and development in the worldwide new energy arena. Edited by Hal Fox.**

***Journal of New Energy*, quarterly, presenting papers representing the new areas of energy research, leading-edge ideas in the development of new energy technology, and the theories behind them. Published by the Fusion Information Center, Inc., for the Institute for New Energy. Editor: Hal Fox.**

KeelyNet BBS - Science and health oriented information exchange that specializes in nonstandard research, much of it on new energy. Jerry Decker, 214-324-3501.
Internet: www.keelynet.com E-mail: jdecker@keelynet.com

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Planetary Association for Clean Energy Newsletter, quarterly, edited by Dr. Andrew Michrowski. 100 Bronson Ave, # 1001, Ottawa, Ontario K1R 6G8, Canada.

Now available: *Clean Energy Review*, a technical and scientific discussion on nuclear fuel wastes disposal. Discusses transmutation as one possible solution. $5 U.S. and Canadian, $7.50 other countries.

Space Energy Journal, quarterly, edited by Jim Kettner & Don Kelly, P.O. Box 1136, Clearwater, FL 34617-1136.

21st Century Science & Technology, P.O. Box 16285, Washington, D.C., 20041. Includes cold fusion developments.

The above list of commercial and information sources will be growing. New listings will be added as information is received. Send information to *NEN*, P.O. Box 58639, Salt Lake City, UT, 84158.

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FUSION SCIENCE MOST IMPORTANT CONFERENCE

Readers may not agree, however, the combination of the two conferences on LOW-ENERGY NUCLEAR REACTIONS are the two most important conferences pertaining to cold fusion, that have been held.

The reasoning is this:

Many workers in cold fusion palladium-heavy water syustems have been prone to ignore nickel-light water cold fusion. Special cold fusion topics, such as sparking under water, sparking in gases, glow-discharge wxperiments, and many other cold fusion experiments have been reporting excess thermal energy or toher forms of acitvity attributed to cold fusion.

now the mechanism that explains most, if not all, of these phenomena has been presetned by Kenneth Shoulders in the Spetember 13-14, 1996 second conference on Low-Energy Neclear Reactions.

Don't miss Issue 3 of Volume 1 of the *Journal of New Energy*. This issue provides the readers of the *Journal of New Energy* with the proceedings of htis important second confernece on Low-Energy Nuclear Reactions.

This issue will chanlge the way you look at the new science of cold fusion!

So dramatic has been the combination of the scientific topics p[resented at the second conference on Low-Energy Nuclear Reactions that this issue has been delayed for a few days to allow for the final preperartion and publication of an important summary paper that ties together many of the important obserevations presented at this conference.

The information provided on the source of nuclear reactions in cold fusion devices may not be the **total** answer. Nature always seems more complex than we perceive. **However, the presentation by Kenneth Shoulders and subsequest coalescing of other important descoveries has opened up a new vista of science that can be treated and understood by classical physics!**

We guarantee that the readers of Issue 3 of the *Journal of New Energy* will view the physical world from a new perspective.

This is the stuff that engenders new Ph.D. theses. Don't miss this issue.

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