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ABSTRACTS

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Oral Presentations

Cold Nuclear Fusion Reactions in Constantan – Successful Experiments

#Dimiter Alexandrov
Lakehead University, Canada
Email: dimiter.alexandrov@lakeheadu.ca

Successfully performed replicable experiments about cold nuclear fusion reactions in constantan specimens are reported. These experiments were performed successfully thanks to the initial author's research in the field of cold nuclear fusion as the corresponding results were partially published in [1].
The experimental scheme consists of gas chamber where the constantan wire specimens were placed and where interaction of these specimens with injected deuterium gas having purity 99.9998% took place. The pressure of the deuterium gas was maintained by mass-flow controller and the temperatures of the specimens were measured by pyrometer. The constantan wires were coiled on alumina rods and initial heating of the wires was performed by electrical power supply, whose heating current and voltage were controlled. Residual gas analyser was used for mass-spectroscopical determination of the nature and the pressures of the gasses in the chamber. Two types of experiments were performed:
i) Several replicable experiments ware performed at initial temperature 950^0C of the constantan wires. In all experiments, explosive evaporations of the wires occurred momentary after the beginning of the interactions of these wires with deuterium gas (D) injected in the chamber. Copper metal release was observed in the experiments (Fig.1). The released excess momentary power was at least greater than 3400W, the density of this power was at least 2280 W/g in terms of the constantan wire and the ratio (Released Excess Power)/(Initial heating electrical power) ≈ 15. No external radiation was registered.
ii) A lot of replicable experiments were performed at initial temperatures of the constantan wires in range 660^0C – 690^0C as the specimens were not destroyed during the experiments and they were used in other further experiments. The heated constantan wires interacted with injected deuterium gas (D) having room temperature and certain pressures for different experiments. The temperatures of the constantan wires began increase at ~8 seconds after the beginning of injection of the deuterium gas and additional increases with 300^0C – 316^0C for different experiments were reached at ~25 seconds. (Both Fig.2 and Fig.3 show the temperature increase for initial temperature 680^0C of the constantan wire.) The released excess power was in range 158W – 179W, the density of the released excess power was in range ~105W/g – 119W/g in terms of the constantan wire and the ratio (Released Excess Power)/(Initial heating electrical power) ≈ 2.7 for different experiments. No external radiation was registered.

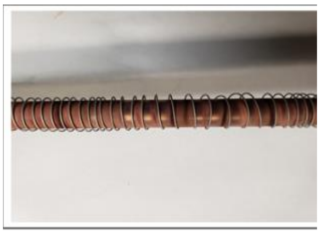

Fig.1: Evaporated Cu metal

Fig.2: Before the interaction with D

Fig.3: During the interaction with D

Although no external radiation (gamma rays and neutrons) was registered, the observed released excess power was of nuclear origin due to the following proofs: *a)* The observed released excess power was not of electrical origin, because the parameters of the heating circuit remained unchanged during the experiments; *b)* The observed release of excess power of chemical origin was ~0.18% of the total released excess power; *c)* Significant density of the released excess power in terms of the mass of the constantan wire; and *d)* Registered release of helium (^{3}He and ^{4}He).

The corresponding ICCF-24 presentation will be based mainly on short videoclips and on pictures proving the successfully performed cold nuclear fusion experiments reported in this abstract.

[1] Dimiter Alexandrov, "Low Energy Nuclear Fusion Reactions in Solids: Experiments", International Journal of Energy Research, **45(8)**, pp.12234-12246 (2021) / Impact factor: 5.164

The limits to growth: the intersection of energy, economics, and geopolitics

[#] Stephen C. Bannister [1]
[1] University of Utah, USA

Email: steve.bannister (at) econ.utah.edu

The June 2007 Proceedings of the National Academy of Sciences (PNAS) article entitled "Global and regional drivers of accelerating CO2 emissions" presented a seminal approach to analyzing the possibly existential issue of anthropogenic greenhouse gas emissions, focusing on the largest component, CO2, of those emissions and its structural drivers. The article's findings were ominous, recalling that the growth rate of emissions had increased from 1.1%y−1 for 1990–1999 to > 3%y−1 for 2000-2004. With fourteen year's added data, and the underlying analytic power of the Kaya model defined in the PNAS article, we are in a position to step back and look at data and probabilities over the longer term.

The model presented here extends the Kaya framework to forecast decelerating CO2 emissions, but likely not quickly enough to avoid significant climate change and avoid global and national energy security tests. This climate-change-negative outcome is because "upstream" system (and model) components are not decreasing either at all or fast enough. The system-driving culprit is the aggregate carbon intensity of primary energy sources. Its actual time path has been increasing since about 2000 in spite of all the hoped-for progress in renewable energy sources. Energy security at the national level has become a crucial geopolitical challenge given the current war in the Ukraine.

A strong conclusion is that if we are to avoid dangerous global warming (a position not shared by all scientists), we must eliminate carbon intensity as a system parameter entirely —that means completely eliminating all carbon-based primary energy sources. Many of the proposed policy responses to the threat have been to raise the carbon price. This has been both politically and economically challenging — the "price elasticity" of energy is low, so that only large price changes make much difference in consumption. A sufficiently large price change would likely raise the average cost of energy, thus curtailing economic output and living standards. And evoking great political resistance.

The energy technologies promised by Condensed Matter Nuclear Science (CMNS) offer a much better alternative — clean sources yield- ing energy costs that are both dramatically lower and more politically feasible. If sufficiently low cost, such sources would expunge carbon sources, perhaps even quickly. And no regulation would have to pass the fraught political processes as politicians almost always claim affinity for "market" forces. These sources are also naturally highly distributed, thus avoiding the energy resource wars that are common throughout history.

Such very inexpensive clean energy sources will invoke other sets of problems — Schumpterian "creative destruction" is one way economists frame the inevitable industrial and commercial turmoil — but this incipient energy revolution may indeed trigger a new Industrial Revolution at least as profound as the original one.

Thus, a realistic model, as attempted here, of our carbon future dramatically emphasizes the critical nature of the research conducted by CMNS scientists. This proposal is for a major update to my presentation at ICCF-22 in Assisi. I have much updated data, and more thoughts about the dangers of failing to abandon carbon sources for energy.

HIVER Electrochemistry
Energy Project Results

Oliver Barham[1], Carl Gotzmer[1], Lou DeChiaro[1]
[1] Naval Surface Warfare Center, Indian Head Division
Email: oliver.barham@nayv.mil

Between 2019 – 2021 the U.S. Naval Surface Warfare Center, Indian Head Division, led a team of government, academic and private industry partners in evaluating claims of cold fusion in the literature, based on the 2013 patented Navy procedure [1]. This presentation will give a brief history of cold fusion for the benefit of the general audience, and then will go into nuclear, thermal and RF results from his effort. This is the first public forum where nuclear, thermal and RF results will all be discussed.

Nuclear results include evidence of MeV-energy particles in CR-39 solid-state nuclear track detectors. Thermal results include excess heat, unexpected based on the amount of electrical current supplied to the cell. RF results include evidence of radio-frequency signals that appear to be correlated with the experiments, and we believe cannot be explained through background environmental electromagnetic noise.

The talk will also address a wider need to publish papers on this topic in top peer-reviewed mainstream journals. For example, the Nature family of journals has published positive LENR results as far back as 1989 [2], and more recently [3], and would be a good candidate family for LENR researchers to target.

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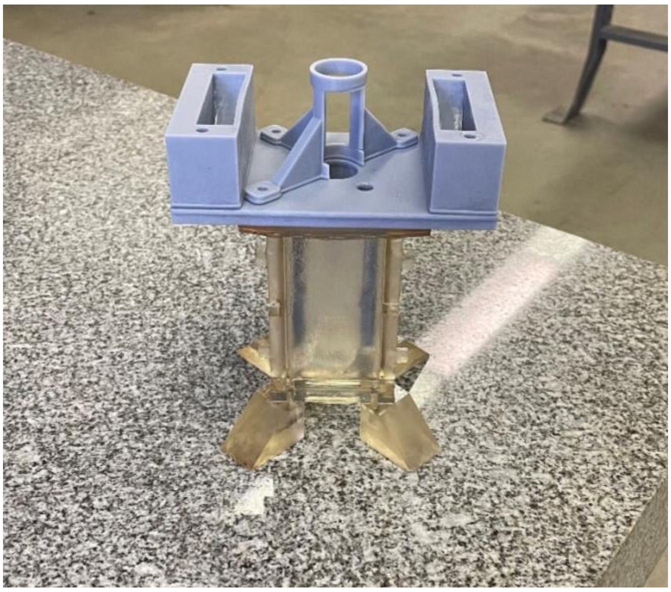
New US Army LENR Replication Efforts: HIVER Co-deposition and Gas Loading

Ben Barrowes[1], Emily Jeng[1], Warren Kadoya[1], Ben Masters[2], Emily Asenath-Smith[1], and Ginger Boitnott[1]
[1] US Army Corps of Engineers, ERDC-CRREL, Hanover, NH, USA
Email: Benjamin.e.barrowes@usace.army.mil
[2]US Army Corps of Engineers, ERDC-CERLL, Champaign, IL, USA

LENR (low energy nuclear reaction) efforts have produced tantalizing results in recent years including reports of transmutations, excess heat, and nuclear products. However, the difficulty of faithfully reproducing the same results in subsequent experiments is hamstringing efforts to involve the broader physics community as well as funding agencies. The sparsity, weakness, and seemingly random nature of activity at nuclear active environments render detection and replications difficult and unconvincing.

The U.S. Army has begun a new effort to investigate LENR by attempting to improve the repeatability and credibility of recent experiments. These replication attempts include a fast co-deposition experiment called HIVER [1], deuterium gas loading experiments [2], and positive pressure hydrogen laser experiments [3]. If improvements can be made such that the same results can be achieved in a repeatable consistent fashion, these experiments can lead to test cases for others to become involved with LENR investigations [4]. Improvements to the HIVER experiment include: more sensitive, more redundant, and closer nuclear product detection and time domain electrical pulse detection.

We report on our initial set up as well as detail the planned improvements to these experiments. Initial results from preliminary experiments, equipment testing, and calibration will also be presented.



[1] Oliver M. Barham, Louis DeChiaro, Kenneth Conley, and Carl Gotzmer "HIVER (H/Pt/Pd/Rh/Li Versatile-modeling and Evaluation of Results) Electrochemistry Energy Project Update", Naval Surface Warfare Center Indianhead, 2021, presented in ARPA-E Low Energy Nuclear Reactions Workshop, Oct. 22, 2021. https://arpa-e.energy.gov/events/low-energy-nuclear-reactions-workshop
[2] Mizuno, T. and J. Rothwell. Increased Excess Heat from Palladium Deposited on Nickel. The International Conference for Condensed Matter Nuclear Science ICCF22. 2019. Assisi, Italy.
[3] Jean-Paul Biberian, Pamela Mosier-Boss, Larry Forsley, "Laser induced transmutation in palladium thin films in hydrogen atmosphere," ICCF23, 2021.
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A Search for Excess Heat: Replication Studies

[#]Edward J Beiting and Dean Romein
[1]TrusTech, USA
Email: ebeiting@ymail.com

During the past few years TrusTech has undertaken replication studies to investigate reported incidences of excess heat in nickel-gaseous hydrogen systems. These studies include work reported by Parkhomov et al, [1], Ahern [2], Mizuno and Rothwell [3], and a variation of work by the Technova group [4]. Much of the results of the replication studies of Ref. 1 were presented previously [5, 6] and only an abbreviated report of the replication of Ref. 2 will be present. The main focus of this presentation will on the replication studies of Refs 3 and 4. The replication work of Ref. 4 is continuing and its presentation here will present the latest results.

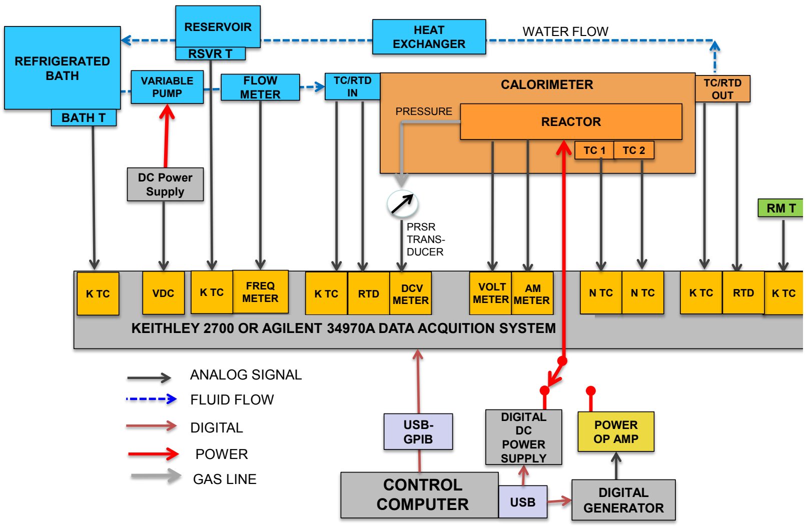

Figure 1. Schematic of experimental configuration.

A schematic of the experimental configuration is presented in the Figure 1. All studies were undertaken by placing samples in an evacuated/pressurized heated reactor cell located inside a flowing liquid calorimeter. The system underwent an automated calibration se-quence before a computer-controlled multi-day con-tinuous data acquisition was recorded.

Figure 2 displays one of the data sets from the Mizuno replication study. The four graphs show (top to bottom) 1) the cell pressure, 2) the input heat power to the cell, 3) the cell temperature, and 4) excess heat power. To date, no significant excess heat power has been observed.

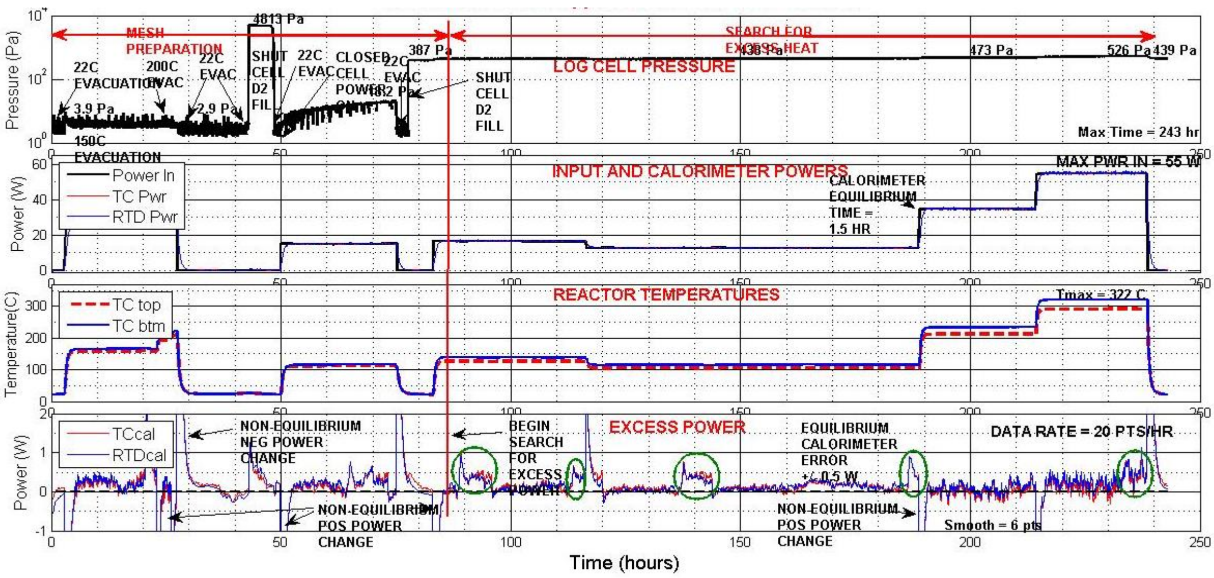

Figure 2. Data acquisition of 243 hours (10 days).

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A Theory for Transmutations Observed as a Result of Deuterium Gas Cycling of a Palladium Silver Alloy

#Theresa L. Benyo [1], Wayne D. Jennings [2], Lawrence P. Forsley [2], Gustave C. Fralick [1], Robert C. Hendricks [1]
[1] NASA Glenn Research Center, Cleveland, OH 44135, United States
[2] HX5, LLC, Cleveland, Ohio 44135, United States
Email: Theresa.L.Benyo@nasa.gov

A series of pressurized gas cycling experiments with a palladium silver (75 wt% Pd and 25 wt% Ag or Pd25Ag) alloy was performed [1]. The alloy was gas-cycled with hydrogen and deuterium in separate runs. Upon analyzing the Pd25Ag tube samples after the experiments, several volcano-like molten features which contained elements other than Pd and Ag were observed. Elements such as Cu, Cr, Fe, Mn, Ti, and Zn were detected in gas-cycled Pd25Ag samples. Table 1 shows a bulk analysis of unexposed and exposed Pd25Ag tubes listing only those elements detected that changed in percentage. For example, although a trace amount of Cu was present in the Pd25Ag coil before the gas cycling, 7 times as much was present after the cycling. Researchers such as Liu et al [2] have also observed transmutations under similar conditions. The results indicate that novel post-test elements were created by suspected nuclear mechanisms. This abstract briefly describes a possible theory for the transmutations observed.

Element	Pd25Ag Results			Units
	Control/Unexposed	Exposed	Δ	
Ag	25.0 ± 0.1	24.9 ± 0.1	–0.1	wt%
Pd	75.0 ± 0.1	75.1 ± 0.1	+0.1	wt%
Cr	Not detected	2 ± 1	+2	ppm
Cu	20 ± 10	140 ± 10	+120	ppm
Fe	20 ± 5	40 ± 5	+20	ppm
Mn	Not detected	0.5 ± 0.2	+0.5	ppm
Si	40 ± 10	30 ± 10	–10	ppm
Zn	Not detected	285 ± 5	+285	ppm

Table 1. ICP-AES results of unexposed and exposed Pd25Ag.

One such available theory from Takahashi et al [3] describes the process of photofissioning Pd into pairs of elements such as Fe + Ca and Ti + Cr. This process involves nuclear excitation by low energy photons present in some D_2O/Pd electrolysis experiments which could only be achieved with high flux photons. We propose a similar theory that involves the process of electron screening [4], d-Ag or d-Pd fusion, and the subsequent fissioning of the resulting unstable Cd or Ag isotope. The electron screening allows the deuteron and the Ag or Pd atom to overcome the Coulomb Barrier and fuse together. The resulting unstable Cd or Ag could fission into pairs such as for Cd: Ti + Fe and Cr + Cr and for Ag: Ti + Mn and Sc + Fe. However, one of the pairs is sometimes unstable and very quickly beta decays into yet another isotope. Both Ti and Fe have been observed on the surface of exposed Pd25Ag tubes as shown in Fig 1 where an absence of Ag indicates that Ag is being depleted via d-Ag fusion. Subsequently, there is an abundance of Ti and Fe at the same location indicating fission.

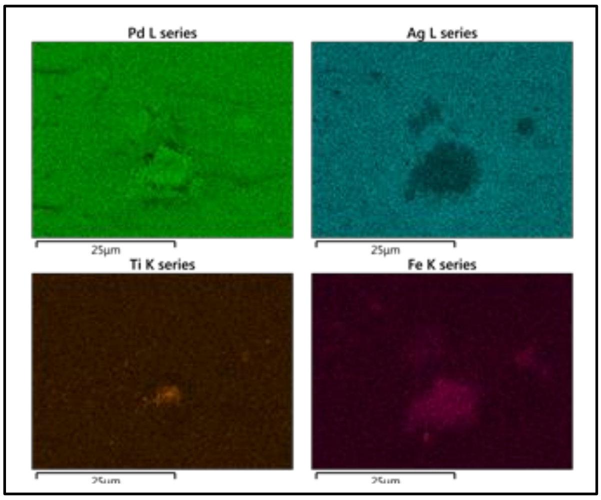

Figure 1. SEM/EDS Color Maps of exposed Pd25Ag tube.

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Excess Heat in Nano Particles of Nickel Alloys in Hydrogen

#Jean-Paul Biberian [1], Robert Michel [1], Christophe Le Roux [2],
Sébastien Bucher [3] Mathieu Valat [4], Arnaud Kodeck[5], Bo Hoïstad [6],
Per J.R. Söberg[6], Jacques Ruer [7]
[1] Vegatec, France
[2] Laboratory GET/CNRS, France
[3] LIFCO, France
[4] Physics Department, Maritime University of Szczecin, Poland
[5] Lakoco, Belgium
[6] Department of Chemistry – BMC, Analytic Chemistry, Uppsala University, Sweden
[7] Sart Von Rohr, France
Email: jpbiberian@yahoo.fr

We have studied the reaction of hydrogen in nano particles of nickel alloys in hydrogen gas at temperatures up to 900°C and observed anomalous heat production.

In the presentation, we will describe the Seebeck type calorimeter. It consists of a quartz cell with diameters from 20 to 40mm heated by a Khantal wire wrapped around the cell and covered by a high temperature cement. The cell is inside a vacuum chamber of 63mm in diameter and 150mm high. The vacuum chamber is constantly pumped by a turbomolecular pump. Two heat screens are placed around the cell to minimize the heat loss. The vacuum chamber is closed by a CF63 flange equipped with electrical feedthroughs for heating the cell and for temperature measurements. The vacuum chamber is inserted inside a double wall cylinder with 50 type K thermocouples in series. The whole reactor is placed in a water tank to keep the outer wall of the reactor at constant temperature. This type of calorimeter allows us to reach high temperatures with low heating power, and a precision better than +/- 150mW.

With this calorimeter we have studied a variety of nano materials based on nickel in various oxide matrices. Our results show the influence of temperature on excess heat. Based on these results, we could calculate the activation energy of the reactions.

The study is part of the Project CleanHME. This project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 951974.

Lattice Energy Conversion Replications

#Jean-Paul Biberian [1], Jean-Philippe Ginestet [2]
[1] Aix-Marseille University, France
[2] Effiblue, Grasse, France
Email: jpbiberian@yahoo.fr

Following the pioneering work of Frank Gordon and Harper Whitehouse [1] of the discovery of a new source of electricity with Lattice Energy Conversion, we decided to replicate and improve the original device. Our first experiments were performed with a 10cm long, 2mm in diameter palladium rod in a stainless-steel tube in hydrogen gas. The experiment with the bare palladium rod did not give any result, but after electro deposition of a thin film of palladium with $PdBr_2$, we measured a production of a DC current, very similar to the one described by Gordon and Harper. Later we did similar experiments, but with coaxial stainless-steel tubes having much larger surfaces, and the power output increased by two orders of magnitude.

In the presentation, we will recall these results, and the new ones with improved surface preparation of the active electrode. We will show the effect of temperature and load on the power output.

References

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Reaction of Hydrogen in Nickel Based Alloys under a Variable Magnetic Field

#Jean-Paul Biberian [1], Eric Marmiroli [2] Patrick Jacquouton [2]

[1] Aix-Marseille University, France

[2] Marseille, France

Email: jpbiberian@yahoo.fr

Nickel is a ferromagnetic metal with a Curie temperature of 358°C. Our goal was to study the influence of a variable magnetic field on nickel and nickel alloys loaded with hydrogen. To do so, we built a machine consisting of sets of powerful magnets placed in two rotating arms. On each side of the arms there are 6 sets of stacks of 3 magnets, with a total of 72 magnets. On one side, we have a magnetic field going up, and on the other side, a magnetic field going down. The magnetic field between the two arms is 0.5 Tesla The arms are activated by two DC motors, so that the frequency of the field can vary between 0.02Hz and 5Hz. See a picture in figure 1.

The active material is placed inside a quartz tube 15cm long and 12mm in diameter closed at one end. The tube containing the material is heated by a Khantal wire wrapped around it and covered with a hugh temperature insulating material. A K type thermocouple is placed at the center of the tube. The tube is then placed inside an insulating box to minimize heat loss, and to minimize the cooling effect produced by the rotating arms. The tube is evacuated by a mechanical pump, and helium is introduced for a blank, at different rotational speeds. After blanks are done at temperatures up to 700°C, hydrogen is introduced, and similar measurements are made. A comparison between blanks and experiments with hydrogen allows us to determine the excess heat.

When there is helium, the curve showing temperature versus electrical heating power is smooth at all temperatures. When hydrogen is introduced, with specific nickel-based materials, there is a sudden temperature jump at the Curie temperature, as shown in figure 2.

During the conference, we will give all the details of the materials that produce this jump, and those that do not.

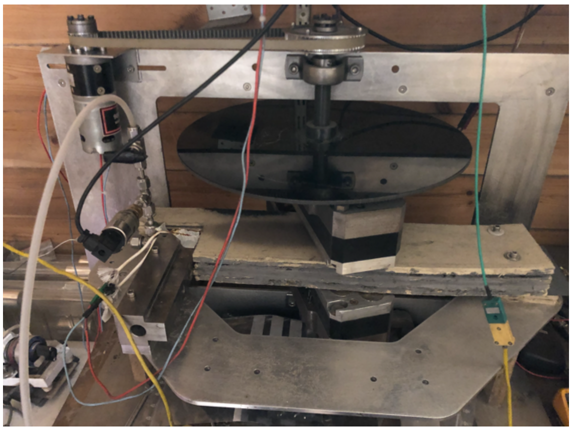


Figure 1

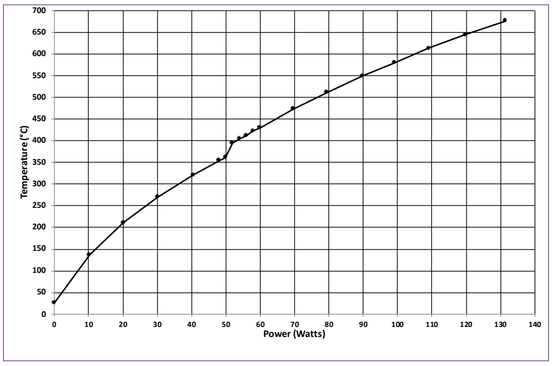
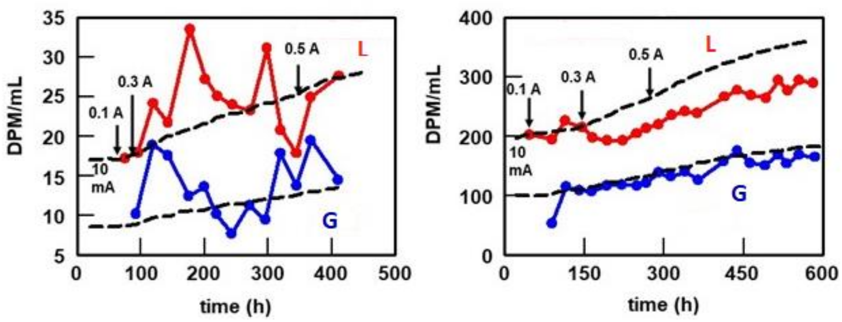


Figure 2

The Case of the Missing Tritium

#Pamela A. Mosier-Boss [1], Lawrence P. Forsley [2]
[1,2] Global Energy Corporation, USA
Email: pboss@san.rr.com

In the Pd/D co-deposition process, Pd is plated out onto a cathode substrate in the presence of evolving deuterium gas [1]. This results in an ever expanding electrode surface consisting of Pd microglobules that instantly load with deuterium. Using variations of Pd/D co-deposition, researchers have reported on observing excess heat, γ- and X-ray emissions, transmutation, as well as the generation of energetic particles. Four groups of researchers have conducted Pd/D co-deposition experiments that focused on tritium production [2-6]. These researchers used different cathode substrates, plating solutions, and methodologies. Lee et al. [6] used a closed cell and measured the tritium content of the electrolyte both before and after electrolysis. Miles [4] used an open cell and measured the tritium content of the electrolyte before and after electrolysis. Bockris et al. [2, 3] and Szpak et al. [4] used a recombiner in a separate compartment which allowed the measurement of tritium content in both the liquid and the gas phases. Typical results are shown below [2, 3]. Regardless of the experimental procedure, an increase in tritium was observed when low-tritiated D_2O was used and a decrease occurred when highly tritiated D_2O was used. In those experiments that saw an increase in tritium, the production of tritium was observed to occur in bursts. During a burst the rate of tritium production was 3000-7000 atoms s^{-1}.



Tritium measurements obtained by Bockris et.al. [2, 3] in the liquid (L) and gas (G) phases for Pd/D co-deposition experiments. Dashed lines are the expected amount of tritium based on the mass balance and isotopic separation factor

The decrease in tritium observed when highly tritiated D_2O was used suggests that there is a nuclear reaction(s) occurring inside the Pd lattice that consumes tritium. This loss of tritium is not observed when bulk Pd is used implying that the reaction(s) involved with the consumption of tritium is related to the high surface area of the Pd deposit and/or the vacancies present in the lattice [1]. In this communication we explore the possible reactions of tritium with Pd and Li isotopes as well as energetic particles to determine what reaction(s) can account for this loss.

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The Electromagnetic Considerations of the Nuclear Force, Part III: An Analysis of the Electromagnetic Contributions to Nuclear Behavior

N. L. Bowen[1]
[1]Colorado Mountain College, Glenwood Springs, Colorado, USA
*corresponding author, email: nbowen@coloradomtn.edu

This paper is Part III of a series of papers [1], [2], describing the concepts of the Electromagnetic Model of the nuclear force—that force which holds together the nucleons in a nucleus. The Electromagnetic Model claims that the nuclear force is a direct result of the electromagnetic forces of the quarks within the nucleons. In this third paper, an analysis of configurations of the nuclides is determined by using the laws of electromagnetics. Previous nuclear theories have relegated the electromagnetic force as being a relatively minor component, considering only the Coulomb force of the protons.

With the understanding that quarks are the centers for both the electric charge and magnetic dipole moments within a nucleon, such outdated assumptions are no longer valid. Because of the strong electromagnetic interaction between the internucleon quarks, electromagnetism can, indeed, be the force that holds the nucleons together in an atomic nucleus. Thus, these changes in the understanding of the electromagnetic forces within the atomic nucleus require a more significant role of electromagnetism with regards to the understanding of nuclear behavior. Part III of this series of papers describes how the electromagnetic forces and energies affect the nuclear behavior. New insights and new understandings are gained by applying the laws of electromagnetics to the nuclear structure inside an atomic nucleus. In this paper, explanations of bond formation and bond breakage are given in detail, as well as how these processes relate to nuclear behavior.

This paper will discuss the subject of quarks and uncertainty principles, the electromagnetic energies within the nucleus, the various segments that comprise the nuclear structure, the process of bond formation, and the process of bond breakage, and how these processes affect the various nuclear decay modes and nuclear behavior

This model asserts that the electromagnetic properties of the quarks are what hold the protons and neutrons together in an atomic nucleus, binding the nucleons together with an internucleon quark-to-quark bond. Using the Electromagnetic Model, the ground state configurations of hundreds of atomic nuclides, from ^{2}H to ^{208}Pb, have been determined and computer simulated. The calculated binding energies agree with the experimental binding energies to within a few percent. These computations are done by using only one selected parameter. No previous theoretical model of the Nuclear Force has been able to demonstrate such an accurate prediction of binding energy with only one parameter, such as this model is able to achieve. This is an unprecedented success, and it strongly indicates the correctness of the Electromagnetic Model. The Electromagnetic Forces inside a nucleus, when fully considered, can explain many aspects about nuclear behavior.

This paper focuses on the Electromagnetic Forces, analyzing how they control and dictate the observable nuclear behaviors, when they are applied to the internal configurations of the atomic nuclides. In Part III of this series of papers, electromagnetic principles are used to analyze nuclear behavior. Numerous examples and calculations illustrate how the Electromagnetic Force, when applied to the quarks, affects nuclear behavior--behavior that previous nuclear models have been unable to solve. The laws of electromagnetics, as applied to the nuclear structure, are able to explain much about nuclear behavior. This model is able to explain many aspects of nuclear behavior with far more clarity than any previous model of the Nuclear Force. By understanding the Electromagnetic Forces within the atomic nuclide, and by applying these forces to the configurations of the atomic nuclei, a stronger comprehension of nuclear behavior can be gained. Thus, by identifying and recognizing the inherent structure within each nuclide, we can achieve more rigorous and accurate predictions of nuclear behavior. This, in turn, can give us a much better understanding of Low Energy Nuclear Reactions.

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Progresses on confirming simple procedures to produce AHE and investigate their origin by thin Constantan wires under H_2, D_2 gases at high temperatures.

#Francesco Celani[1,2,4], C. Lorenzetti[1,2], G. Vassallo[1,2,3,4], E. Purchi[1,2], S. Fiorilla[1,2], S. Cupellini[1,2], M. Nakamura[1,2], P. Cerreoni[1,2,4], R. Burri[1], P. Boccanera[1,2], A. Spallone[1,2,4], E. F. Marano[1,2].
(1) ISCMNS_L1: Intern. Soc. of Cond. Matter Nucl. Science, Via Cavour 26, 03013 Ferentino (FR)-Italy; (2) EU Project H2020: CleanHME; (3) DIDI, Univ. of Palermo, 90128 Palermo (PA)-Italy; (4) Ist. Naz. Fis. Nucl., Via E. Fermi 56, 00044 Frascati (RM)-Italy. #francesco.celani@lnf.infn.it #franzcelani@libero.it

Following the efforts to find ***simple procedures*** to activate the specific material we developed (since 2011; based on surface-modified Constantan in the shape of long and thin wires, Joule heating), able to produce measurable values of AHE we reproduced them. Made new specific tests to investigate also ***isotopic effects***. Moreover, according to our interpretation of the results, the ***main origin of AHE*** seems reconfirmed: in agreement with the initial (some since 1989) results of Researchers in USA, Japan, Italy. The work was originated because we would like to reconfirm the procedures we discussed deeply, both at the talk and after waiting 1 month for questions (by web), during the ANV8 Workshop: held in Assisi-Italy on December 2021 (DOI: 10.13140/RG.2.2.27006.6683). Such presentation got a quite large interest among the LENR-AHE community and several questions were raised, specially about its *effective reproducibility*, i.e. restarting from the beginning: wire and its treatments. Moreover, we added *new experiments* related to study isotopic effects (by H_2, D_2) if any, in respect to the amount of AHE.
The geometry of the reactor's core is almost the same we developed since 2019: "inverse coaxial coil" (cfr. DOI document). Energy balance (at several fixed input powers, step like) were made by thermometry (because possibility of much faster measurements in respect to usual flow calorimetry) using, as references, experiments made under He gas at the beginning of the tests, with similar pressures (usually >0.5 bar) of the active gases (H_2, D_2). We considered useful for the energy balance the temperatures (by K type thermocouple, SS shielded) measured at the external wall of the glass reactor: surface covered by several layers of thermal conducting thick Al foil with side toward ambient painted by high emissivity (>90%)-high temperatures (800 °C) black compound. The maximum temperatures were: internal 900 °C, external 380 °C. Maximum power applied was >150 W. Wire's weight is 0.45 g.

We ***reconfirm*** that the simple procedure, just DC Joule heating at high power (100-150 W) and long times (50-150 h), was effective to activate a virgin Constantan coil with thin wire's surfaces properly treated (mainly by Low Work Function materials). Again, we found that the AHE measured, during the cooling cycles from the highest power, depends on the time previously spent by the reactor's core at the highest powers. We found that there is a sort of "positive memory effect" (in respect to AHE), lasting usually 10-20 h. Moreover, AHE increases increasing the number of cycling (high->low->high power). We found, also, that increasing the wire resistance by proper "aging" treatments, increased the amount of AHE. We speculated that it could be related to increased surface area, spongy like, of the wire that allows, among others, easier income<-->outcome of active gases, i.e. ***flux***. We measured that D_2 gas (latest experiment) gave larger values of AHE (9 W) in respect to H_2 (5 W), at input power of 130 W.
BTW, AHE are related to the voltage drop along the wire (as larger as better): possible candidates are electromigration, NEMCA, "Preparata" effects. We observed such behaviour even since 1995 by using long-thin Pd wires. Obviously, our speciality of high-peak-power pulsing procedure (at proper duty cycles) is the most promising to increase both the AHE and overall COP of the system: toward practical applications. In the whole, the flux of gas (i.e. ***forced non-equilibrium***) from the surface and/or along the bulk of the wire seems to be the origin of AHE. Such observation was pioneered by G. Fralick (NASA-USA); A. Takahashi, Osaka Univ.-Japan; Y. Iwamura, MHI-Japan; our Group-Italy. Further new tests are on-going based on hybrid procedures: results will be reported at the ICCF24 Conference.

The Project CleanHME has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 951974.

Excess Heat in a $D_2(H_2)$-Ni(Pd) Reaction System with Multiple Oxidation of the Ni-Pd Alloy Powder

Hang Zhang , Si Chen
Qiuran Lab, Xi'an, China

Email: 715469127@qq.com

The objective of this experiment is to study how oxidation of Ni-Pd alloy powder would affect the excess heat in a $D_2(H_2)$ Ni-Pd reaction system. The reaction system and calorimetry in this experiment were the same as that reported in [1] .

The reaction vessel was filled with hydrogen (at 500kPa), deuterium (at 300kPa) and air(1 atm) sequentially with vacuum pumping before filling of a different kind of gas. The hydrogen and deuterium were input for reaction with different heating power from 10W to 300W. The reaction time was controlled at a range of 8-12 hours. The air was input for Ni-Pd alloy powder oxidation at 450 °C for 20 hours. The above procedure was repeated 3 times.

The results show that similar level of excess heat was observed for both deuterium and hydrogen with the heating power above 150W. A maximum of 2W excess heat was reached at the input heating power of 250W after third oxidation.

In conclusion, the effect of oxidation on excess heat was confirmed in a $D_2(H_2)$ Ni-Pd reaction system, which is the consistent with that reported by previous studies[2,3].

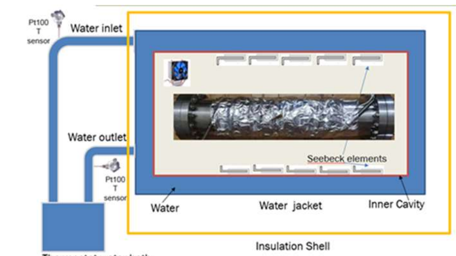

Figure 1: The reaction system and calorimeter

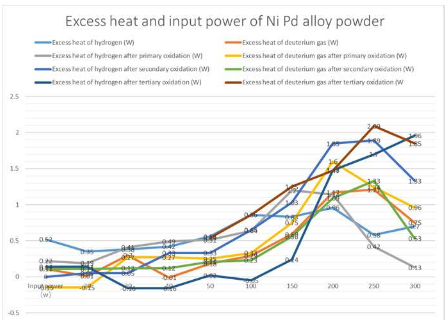

Figure 2: Excess heat versus input power and oxidation

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Exotic Neutral Particles as a comprehensive explanation for CMNS

#William Collis[1]
[1] ISCMNS, United Kingdom
Email: , billcollis (at) iscmns.org

This paper explains anomalies in hydrogen loaded metals in terms of catalytic neutron transfer by Exotic Neutral Particles (ENPs) by making radical innovations to the models of Bazhutov and Fisher, simplifying their assumptions while simultaneously improving the match with observation. It is shown how penetrating radiation is rarely produced and evidence is offered showing new interpretations of Q/^{4}He, tritium and neutrons. Excess heat production without penetrating radiation is explained in the Ni/H, Ti/D, Pd/D, Li_2SO_4. Conversely observed radiation from Cl and Rb is explained.

Keywords: Heat–He correlation, Exotic Neutral Particles, penetrating radiation

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Experimental and theoretical arguments for the DD threshold resonance in ^{4}He

Konrad Czerski[1], Rakesh Dubey[1], Mateusz Kaczmarski[1], Agata Kowalska[2], Natalia Targosz-Ślęczka[1], Mathieu Valat[1]

[2] Institute of Physics, University of Szczecin, 70-451 Szczecin, Poland

[1] Physics Department, Maritime University of Szczecin, 70-500 Szczecin, Poland

Email: konrad.czerski@usz.edu.pl

The electron screening effect enhances the ^{2}H(d,p)^{3}H reaction rates at thermal energies by many orders of magnitude depending on the metallic environment and its local crystal structures [1,2]. The resulting reduction of the Coulomb barrier height, however, cannot change the branching ratio of the DD reactions at room temperature compared to that determined in accelerator experiments at the deuteron energies of few keV in which the proton and neutron channels are the strongest. The dominance of the ^{4}He channel observed in the cold fusion experiments and lack of observation of any gamma rays [3] can be explained by the excitation of the DD threshold resonance in the compound nucleus ^{4}He [4]. This resonance should have spin and parity $J^{\pi}=0^+$ and be very narrow with a total width below 1 eV, which may explain why it could not be observed before.

For the first time, the DD threshold resonance was found in the experimental study of the ^{2}H(d,p)^{3}H reaction in the Zr target performed under ultra-high vacuum conditions [2]. A similar resonance contribution was also recognized [5] in the older data of the gas target experiment [6], which enabled to estimate the partial proton resonance width at several tens meV. On the other hand, it has been recently predicted that this resonance should decay predominantly by the internal electron-positron pair creation [5]. Here, both theoretical calculations of the DD threshold resonance width and the first experimental results confirming electron-positron pair emission from this resonance will be presented. Based on these data, the DD reaction rates at thermal energies and the corresponding branching ratios will be determined. Particular attention will be paid to study the interplay between the electron screening effect and threshold resonance excitation, which can explain difficulties in the reproducibility of cold fusion experiments.

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Experimental Observations on the LEC Effect

Antonio Di Stefano
Prysmian Electronics s.r.l., Italy
Email: antonio.distefano@prysmiangroup.com

The Lattice Energy Converter (LEC) [1] is a relatively simple gas-metal device that is able to directly generate an electric voltage and current by an, up to now, unexplained effect, possibly related to LENR. Due to its simplicity and high reproducibility [2], the LEC is a very interesting device that may provide insights on LENR phenomena, as well as being a new solid-state energy source.

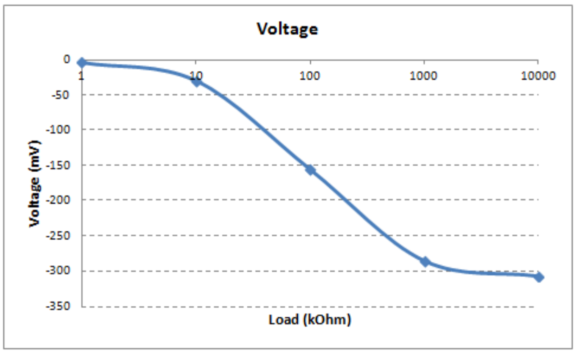
This paper describes a successful replication of a Lattice Energy Converter (LEC) and a number of experiments and observations made to investigate the nature of the effect, its electrical characteristics and to exclude the presence of artefacts and conventional explanations.

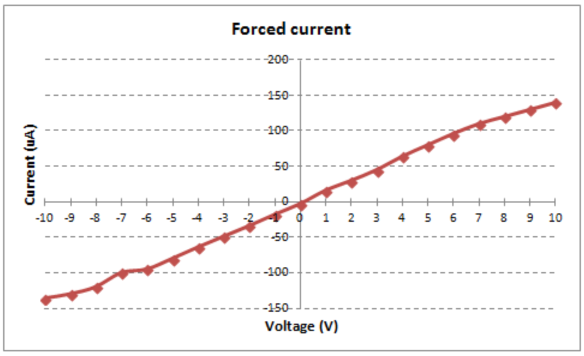
The device was realized with two small coaxial brass tubes, by electrochemically co-depositing iron and hydrogen on the inner electrode (the so-called Work Electrode, WE). The choice of iron instead of palladium was made to simplify the realization of Working Electrodes and to lower their cost.

Compared to a control device, the active LEC was able to generate a stable voltage in excess of 300 mV and a current up to a few µA. When an external voltage was applied, the device was able to sustain a current up to 0.15 mA with ±10 V, i.e. more than 6 order of magnitude compared to the control device. This behaviour is consistent with the ionization of the gas inside the device, as previously reported by Rout and Srinivasan [3] in similar conditions. The fact that the energies required to ionize the gas are at least one order of magnitude greater than typical chemical energies, suggests that a LENR-like phenomenon may be involved.

Experiments allowed to verify that the generated voltage and its polarity are dependent on the specific metal pair used, that the co-deposition step is essential to obtain the effect and that no radiation can be detected by using an ordinary Geiger-Muller counter.

The obtained results are consistent with the ones described in [1], [2] and [3]. Also, the good reproducibility of the LEC is confirmed. The primary effect happening in the device seems to be the apparent ionization of the gas between the electrodes, allowing a current to flow through an otherwise insulating gap. The spontaneous voltage measured between the two electrodes is instead a secondary effect, due to the presence of a bimetallic pair in contact with an ionized conductive medium (the gas layer), forming a kind of gas-phase galvanic battery.





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Experimental study of electron emission in the DD reactions at very low energies

#R. Dubey[1], K. Czerski[1], M. Kaczmarski[1], A. Kowalska[2], N. Targosz-Sleczka[1], M. Valat[1],
[1] Institute of Physics, University of Szczecin, 70-451 Szczecin, Poland
[2] Institute of Mathematics, Physics and Chemistry, Maritime University of Szczecin, 70-500 Szczecin, Poland
#Email: rakesh.dubey@usz.edu.pl

Domination of the ^{4}He production over other deuteron-deuteron (DD) nuclear reaction channels and its strong correlation to the heat excess measured in the cold fusion experiments [1] can be easily explained by the DD threshold resonance [2]. This resonance was unambiguously observed in the ^{2}H(d,p)^{3}H reaction at deuteron energies as low as 5 keV [3], supporting the spin and parity assignment $J^\pi=0^+$. It means that this resonance cannot decay directly by gamma ray emission to the ground state of ^{4}He. Recently, the partial resonance width of the internal electron-positron pair creation has been theoretically calculated and demonstrated [4] that its value can largely exceed that of the proton one and mainly contribute to the cold fusion heat excess.

In this work, we present the first observation of the electron emission from the DD threshold resonance. The experiment was performed at the eLBRUS Ultra High Vacuum Accelerator Facility of the Szczecin University in Szczecin, Poland [5]. The deuteron beam was accelerated to energies ranging from 6 to 16 keV, with the constant current beam of 40 µA using the magnetically analyzed single-charged atomic and molecular deuterium ions. The electrons and protons resulting from the DD reactions were detected using only one Si-detector of 1 mm thickness to reduce the experimental uncertainties. The measured electron energy spectrum agreed very well with the model expectations based on the Geant 4 simulation [6] and careful detector calibration using the beta radioactive sources.

The determined electron-positron resonance width seems to slightly overestimate the proton width. The theoretical analysis shows that more exact results are expected for experiments performed at deuteron energies below 5 keV which are planned for the next future.

The study is part of the CleanHME project. This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 951974.

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Direct Electric Energy Production by LENR

#Dr. George Egely[1],
[1] Budakeszi, Hungary

Email: egely@egely.hu

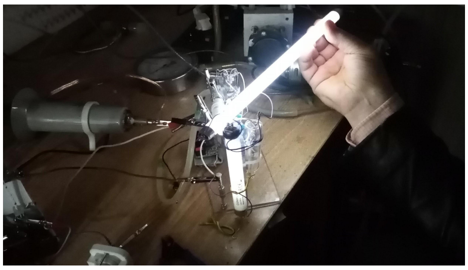
The production of safe, inexhaustible electric energy is the holy grail of a sustainable economy. Various options offer partial solutions. In fact, LENR offers only advantages without drawbacks. The test results demonstrate the technical reality of this aim.

A system is presented consisting of three parts:

1. Pulsed voltage input,
2. The reactor tube using spark discharge in hydrogen isotope gas,
3. A harvesting circuit, which is an impedance matching device, like a gearbox in a car.

The LENR process takes place during and after a spark discharge. We built a small system due to financial limitations, where the input current is in the μA range, and the voltage doesn't exceed 3 kV. After the LENR process during the sparking, the output appears as fast, high-voltage pulses of up to 30 kV, thus limiting digital data acquisition.

In order to have reliable power balance data, both the input and the output pulsed currents flow through thermostated ohmic resistors. Thus the time-averaged input and output electric power is measured in a conservative manner by calorimetry. Only the electric energy output (turned into heat by the resistors) is considered, all other output energy forms like heat, sound, or light were neglected. Sometimes we use neon discharge tubes besides the ohmic load to harvest ultra-fast electromagnetic transients as well.



Usually, the output/input COP is 3-4, but under perfect resonant matches we measured COP up to 10.

The effect appears only in a disturbingly narrow range of parameters like pressure, electrode distances, voltage, harvesting impedance and plasma acoustic resonance.

Outside of this narrow range the COP is down to 0.1-0.2, which is the realm of textbook physics. The effect has not been observed in other gases like helium or dry air.

After some time, especially at large-current output pulses, carbon appears on the cathode surface during a gradual build-up. The power density on the cathode surface is considerable both spatially and temporally. The discharge frequency must be limited to keep the cathode cool, to prevent damage to it.

We believe that this fusion effect is catalyzed by quasi-particles, notably surface plasmons and condensed plasmoids. As such, it is the macroscopic analogy to muon-catalyzed fusion. Footage will be presented to demonstrate the experimental device.

Ion beam experimental set-up and results so far

#S. Forbes, P. L. Hagelstein and F. Metzler
First Affiliation, First Country
Email: plh@mit.edu

Soon after the Fleischmann-Pons announcement there were reports of low-level energetic charged particle emission from metal deuterides in electrochemical, plasma loading and in ion beam experiments. Such experiments have not drawn the attention they probably deserve in the field since the effects are small, and excess heat was not observed. Our interest was drawn to these experiments due to the presence of MeV particles which signifies that a nuclear process is involved.

A candidate mechanism that might account for the energetic particles is nuclear excitation transfer, where the large 24 MeV quantum from the $D_2/^4He$ transition is transferred to another nucleus, resulting in disintegration. From this mechanism it is possible to determine expected energies for alphas, protons, neutrons and other energetic particles, given a knowledge of what nucleus disintegrated. A goal of the experiment is to develop a correlation between product particle, energy, and target nucleus, from which it should be possible to determine whether nuclear excitation transfer is involved or not. The $D_2/^4He$ transition has been proposed as a first step in excess heat generation, so by observing low-level energetic particles we have the possibility of learning about part of the mechanism involved in excess heat production.

Motivated by these considerations an ion beam experiment was designed and implemented, capable of H and D bombardment on metal foils with ion energies up to about 1 keV and an ion current up to a few mA.

A few energetic ions above 20 MeV were seen in early experiments with D ions on Ti, and a possible correlation between neutron and ion emission. A neutron burst was seen about 12 hours after D ion bombardment of Cu. We have some experience with H ion bombardment on Li.

An upgrade of the experiment which brings a charged particle detector close behind a thin foil is in progress, which is hoped to increase the collection efficiency by a factor of 50 or so. Results from new experiments with this configuration will be presented.

Electron Screened and Enhanced Nuclear Reactions

#L. Forsley,[1,2]
[1]NASA Glen Research Center, USA
[2] Global Energy Corporation, LLC, USA
Email: lawrence.p.forsley@nasa.gov

In 1954, Salpeter [1] calculated nuclear reaction rates would increase via weak and strong electron screening in stars. Astrophysical observations and laboratory astrophysics experiments have confirmed that electron screening reduces the Coulomb Barrier between charged particles. Fermi degenerate strong screening occurs when the electron density exceeds 10^{23} electrons/cm^3 in the cores of gas giant planets, White Dwarf Stars, the conduction bands of metals, deuterated LENR materials and Inertial Confinement Fusion targets at maximum compression. We have modelled these quantum mechanical effects with Density Functional Theory codes.

Changes in the decay rates of electron capture (*EC*) and isomeric transition (*IT*) radioisotope decays have been discussed for nearly a century where atomic shell electrons influence *EC* and *IT* decays.[2] Whereas the Born-Oppenheimer Approximation (BOA) treats electron and nuclear wavefunctions separately, the BOA breaks down in *EC* and *IT* decay. Changes in half-life have been observed in ^{7}Be *EC* and ^{57}Fe and ^{99m}Tc *IT* decays. The effect most often occurs through the compression of the *s* shell electrons.

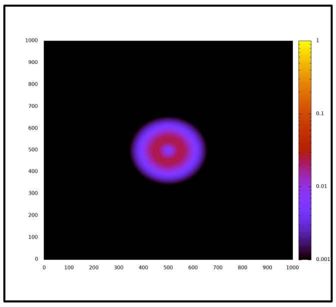


Figure 1 Be-7 electron density

Radioactive ^{7}Be ($1s^2 2s^2$) decays by capturing a K-shell electron with a nominal 53-day half-life and a 478 keV γ emission. Experiments by Ohtsuki, *et al* [3] and others have demonstrated the environment-induced half-life change. Two of the experiments used ^{7}Be embedded within a C_{60} fullerene buckyball as modeled in Figure 2 and a third observed it embedded in Al, Pd and Pb: each with different crystal structures. The researchers consistently observed a 0.8% reduction in ^{7}Be half-life embedded within *C_{60} and Pd* versus a Pb or Au matrix, and attributed this to *C_{60} and FCC Pd lattice compression* of the $^7Be_4$ $1s^2 2s^2$ shells. Earlier ^{7}Be diamond anvil compression experiments by Hensley, Bassett and Huizenga [4] showed similar results.

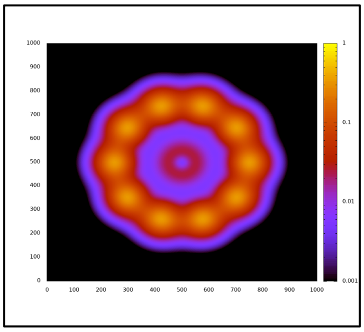


Figure 2 C_{60} Compressed Be-7

Our Quantum Espresso Density Functional Theory (DFT) calculation confirmed 1% compression of the outermost Be $2s^2$ shell in Figure 2 as compared to a bare Be atom in Figure 1. This is consistent with C_{60} and Pd experimental observations with 0.8% ^{7}Be half-life reductions. The *s* shell compression increases the nuclear residence time of the electron with increased electron-quark interaction via the weak force. A proton *up-quark* converts to a *down-quark* resulting in a neutron and an electron neutrino, ν_e. *Significantly, DFT calculated s shell compression correlates with the observed half-life reduction* lending support that DFT lattice codes can accurately model nuclear-electron screening effects.

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Contamination, Transportation or Transmutation in LENR Material Analyses

#L. Forsley,[1,2] T. Benyo[1] and W. Jennings[1,3]
[1]NASA Glen Research Center, USA
[2] Global Energy Corporation, LLC, USA
[3] HX5, USA
Email: lawrence.p.forsley@nasa.gov

LENR experiments using various loading and triggering mechanisms rely on a variety of elemental and isotopic assays to determine LENR effects. These assays include optical microscopy, Scanning Electron Microscopy with Energy Dispersive X-Ray Analysis (SEM/EDX) [1], X-Ray Photoelectron Spectroscopy (XPS) and Transmission Electron Microscopy (TEM). All of these methods observe the surface of a material. By dissolving or vaporizing the sample, Inductively Coupled Plasma Optical Element Spectroscopy (ICP-OES) can determine elemental composition (ppb) or with mass spectroscopy, isotopes (ICP/MS). One can use a focused ion beam (FIB) to cut open a sample and observe the "cut" with either SEM/EDX, or Time-of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS). High Purity Gamma Ray Spectroscopy (HPGe) and alpha/ beta Liquid Scintillator spectroscopy can be used. We've employed these assay methods in our NASA GRC research under both the Advanced Energy Conversion [2] and Lattice Confinement Fusion Projects. However, there are limitations associated with each of these methods ranging from handling contamination, instrumental limitations including sensitivity and field of view, and sample preparation.

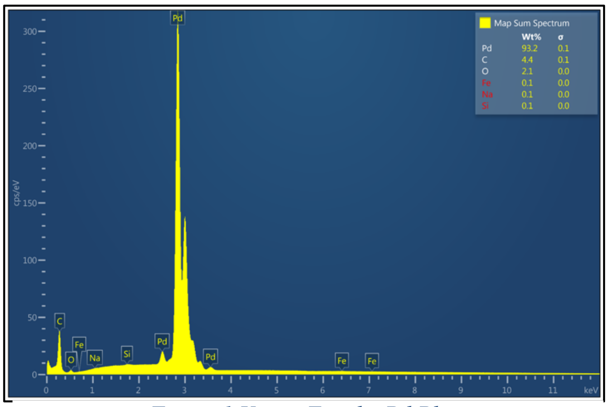

Figure 1 Virgin Tanaka Pd Plate

Recently, we used SEM/EDX at NASA GRC to examine Tanaka Precious Metals unused Pd plate and a used cathode from 1990. These samples were from experiments by L. Forsley and J. Jorne at the University of Rochester. Forsley had arranged for the cathode to be examined at the Nuclear Structures Research Laboratory by Atomic Mass Spectroscopy but the analyses were declined by J. Huizenga.

Figure 1 is the EDS Map Sum Spectrum of the unused 2.54 cm square sample that predominantly consists of Pd metal with *some contaminants* including Na, Si and Fe. Figure 2 is the same type of spectrum of a 0.5 cm x 2.54 cm cathode after electrolysis in a calorimeter. It contains a variety of elemental spectral lines including Pb, Sn, Cu, Cr, Fe, additional Si and Ca. However, the cathode was run in *a borosilicate glass tube*, providing Si, and had *lead-tin soldered copper wires* leading to the power supply. Each of these sources complicates whether potential Pd cathode transmutation, source material contamination or transportation from elsewhere in the experiment occurred. Even isotopic analyses, not performed here, can lead to misunderstandings, such as the variable ratio of $^{6}Li/^{7}Li$. Yet, with care, isotopic and elemental analyses can provide evidence of nuclear transmutations indicating LENR occurred either in the cathode or nearby witness materials.

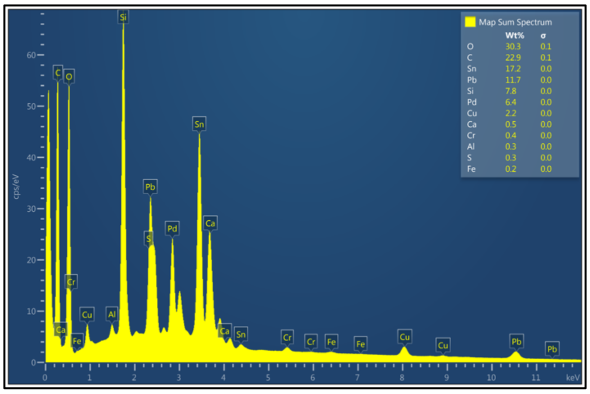

Figure 2 Electrolytically Run Tanaka Cathode

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Earth factories: Nuclear transmutation and the creation of the elements[1]

#Mikio Fukuhara [1], Alexander Yoshino [2], Nobuyuki Fujima[3]
[1] New Industry Creation Hatchery Centre, Tohoku University, Sendai, Japan
[2] Computer Science, University of Toronto, Canada
[3] Faculty of Engineering, Shizuoka University, Hamamatsu, Japan

Email: mikio.fukuhara.b2@tohoku.ac.jp

Abstract
Stellar nucleosynthesis is a widely acknowledged theory for the formation of all elements in our universe; traditionally we say the highest mass stars transmuted lighter elements into heavier elements lighter than iron. Here we propose that the formation of the 25 elements with smaller atomic numbers than iron resulted from an endothermic nuclear transformation of two nuclei confined in the natural compound lattice core of Earth's lower mantle at high temperatures and pressures. This process is accompanied by the generation of neutrinos and is influenced by excited electrons generated by stick-sliding during supercontinent evolution, mantle convection triggered by major asteroid collisions, and nuclear fusion in the Earth's core. Therefore, our study suggests that the Earth itself has been able to create lighter elements by nuclear transmutation.

Introduction Regarding Earth's formation, it is generally believed that the terrestrial planets have formed by accretion of solid materials that condensed from the solar nebula approximately 4.56 billion years ago [2]. Resultingly, whole-Earth geochemical models, which are primarily based on cosmochemical abundances, provide specific limits on the possible chemical composition of the Earth's deep interior [3].

In disagreement with this theory, Fukuhara proposed a model for the formation of nitrogen, oxygen, and water using circumstantial evidence based on the history of the Earth's atmosphere. This hypothesis suggests that heavier elements result from an endothermic nuclear transformation of carbon and oxygen nuclei confined in the aragonite $CaCO_3$ lattice of Earth's mantle or crust, which is enhanced by the attraction caused by high temperatures ≥ 2510 K and pressure ≥ 58 GPa in the Earth's interior [4]:

$$2{}^{12}C + 2{}^{16}O + 4e^* + 4\bar{\nu}_e \rightarrow 2{}^{14}N_2\uparrow + {}^{16}O_2\uparrow + {}^{1}H_2{}^{16}O\uparrow + 2n \quad -10.58\ \mathrm{MeV} \qquad (1)$$

We considered the possibility of element production from lighter to heavier elements in minerals of the Earth's interior under high pressure and temperature in terms of endothermic nuclear transformable reactions. However, to the best of our knowledge, theories of element creation have not been previously developed in the context of an "Earth factory" as described herein.

Methods The crystal structures of mineral compounds were drawn by using ATOMS 6.4 and CorelDRAW2020, using the structural data obtained from single-crystal X-ray diffraction measurements. To calculate the smallest endothermic formation energies, an algorithm was written to iterate through reactant elements for approximately 150,000 equations and calculate the final values, after which filtering was conducted based on element type and the final values were obtained.

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Increasing the output of the Lattice Energy Converter

#Frank Gordon [1], Harper Whitehouse [2]
[1] INOVL, Inc, USA
[2] INOVL, Inc, USA
Email: feg@inovl.com

Multiple Lattice Energy Conversion (LEC) devices and configurations have experimentally demonstrated the ability to self-initiate and self-sustain the production of a voltage and current through an external load impedance without the use of naturally radioactive materials. These results have been reported by the authors[1, 2, 3, 4] and replicated by independent researchers [5, 6, 7, 8, 9]. A video,[10] shows that a voltmeter and a resistance substitution box are all that is required to observe and measure LEC output which for this test produced a several hundred nanowatts of power per square centimetre of working electrode surface area.

While the ability to self-initiate and self-sustain the production of a voltage and current through a load is a significant innovation, the output must be scaled up by 6 orders of magnitude to produce a few watts, and by 9 orders of magnitude to produce a few kilowatts. Based on a review of the literature and an analysis of experimental results, five focus areas have been identified to scale up the LEC output including:

1. Improved metallurgy to increase the production of ionizing radiation;
2. Increased gas density (initial pressure) to increase gas ionization.
3. Improved LEC cell configurations to increase gaseous ion harvesting efficiency;
4. Elevated temperatures leading to increase power output;
5. Increased electrode surface area.

For each of the five focus areas, additional experiments and analysis are required to:

1. Identify the source and type of ionizing radiation emitted from the working electrode;
2. Identify the role that the counter electrode may play in ionizing the gas;
3. Identify gases and mixtures that optimize the production of ions;
4. Analyse the gas ion physics within the cell which is a 4^{th}-order nonlinear differential equation.

This paper examines each focus area and identifies possible actions to increase LEC power output.

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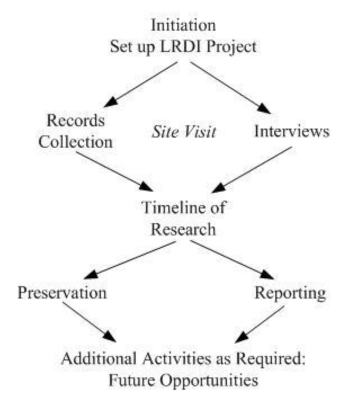
LENR Research Documentation:
What Have We Learned So Far?

#Thomas W. Grimshaw, Ph.D. [1]
[1] LENRGY, LLC, USA
thomaswgrimshaw@gmail.com

The LENR Research Documentation Initiative (LRDI) objectives are to document and archive LENR records while they are still available. A lot of progress has been made in meeting these objectives. Almost 30 participants are engaged, and about 25 project reports have been prepared[1]. The scope has now been extended to document and preserve important materials, such as newsletters and websites, that are of great importance to LENR but not necessarily involving someone still active in the field.

Much has been learned about both the LRDI methods[2] and the availability and characteristics of LENR research records. The procedure developed in the pilot project with Ed Storms[3] has been refined and reconfigured as necessary for each participant and project. As may be expected, given the marginalized status of the field, the records vary widely in the type of research being done, the completeness of recording experimental results, the state of preservation, and the methods used originally for reporting. The Marriott Library of the University of Utah has a strong interest in LENR records and has been established for long-term archiving of LRDI participants. The files of one LRDI participant have been provided to the Special Collections at the Library.



LRDI Procedure

While a lot of progress has been made, a great deal remains to be done in capturing, documenting, and preserving the invaluable records of LENR investigations. Plans call for continuing the LRDI both for historical preservation and to keep the records available for potential re-analysis to help understand LENR and realize its potential benefits.

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The Role of Appropriate Calorimetric Methods for Scaling-up LENR Devices and the Irrelevance of Coefficient of Performance (COP)

#Daniel E. Gruenberg [1], Tadahiko Mizuno [2]
[1] Mizuno Technology, Inc., Thailand
[2] Hokkaido University, Japan
Email: daniel@mizunotech.com

We report on major advances in the development of practical and large scale LENR devices. Calorimetric methods have significant influence on results of replications and validations of Mizuno-type LENR reactors. We have identified ways to dramatically improve the stability and reliability of LENR excess heat measurements based on well-established thermodynamic and calorimetric principles and have postulated possible mechanisms for the variability in previous experiments. By adapting these new calorimetric methods, we have identified key variables which are now allowing us to scale-up to practical LENR-based devices for industrial heating and combined heat and power units in the kW-class and MW-class scale. Theoretical power density is sufficient to allow for the possible replacement of dangerous radioactive fissile fuel rods with LENR-based fuel rods to dramatically improve the safety of existing nuclear power reactors. Also, notably the irrelevance of COP as a method to compare disparate LENR devices has become abundantly clear. Mizuno-type LENR devices are temperature-dependant heat sources [1] which, together with the calorimeter, form two parts of an inseparable system. Nuclear active environment (NAE) sites [2], spatially, are randomly distributed and are highly sensitive to even slight variations in temperature in Mizuno-type LENR devices. The physical distance between the resistance wire heating elements wrapped around the device significantly affects the variability in previous excess heat measurements. In addition, airflow calorimeters cannot support high & even temperatures which lead to difficulties in replications. After changing to an oven-type calorimeter, most of the previous variability has been ameliorated, possibly by providing very even temperature distribution across the randomly distributed nuclear-active sites and allowing testing at higher absolute temperatures relative to previously published calorimetry measurements.

Another consequence of our research has shown that COP can vary from 1 to infinity with the same device, depending upon the design of the calorimetric system used. The balance of excess heat production and heat outflow affects temperature of the LENR device, which in turn affects the quantity of excess heat. Using small-scale Mizuno-type LENR reactors (7cm Ø, 25cm L) in an oven type calorimeter, as a model system, excess heat varied exponentially with temperature. At 435°C, excess heat output was 45W, which increased to >200W at 593°C. It was found that by doubling catalyst surface area, excess heat production was roughly doubled. Excess heat production at this temperature was consistently 0.22W/cm^2 and is expected to increase exponentially at higher temperatures, certain experiments have reached 1-10W/cm^2 which means a home CHP unit could be designed to be roughly the size of standard home split unit air conditioner. We are now designing and building practical kW-class reactors in-house and MW-class reactors in collaboration with a major national university in Japan based on the above theoretical temperature dependence and excess heat production per unit surface area results, as well as constructing more precise calorimeters which coincidentally produce very high COPs, perhaps infinite in certain cases.

The reliability and precision of these measurements are unprecedented in the LENR field and represent a key element of moving the technology forward towards more practical devices.

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Models for accelerated nuclear deexcitation: Dicke-enhanced excitation transfer on the 14.4 keV transition in Fe-57

[#]P. L. Hagelstein[1], F. Metzler[1] and N. Galvanetto[1,2]
[1] Massachusetts Institute of Technology, USA
[2] University of Zurich, Switzerland
Email: plh@mit.edu

Numerous anomalies have been reported over the decades in experiments with metal deuterides and metal hydrides, including excess heat production and low-level energetic nuclear particle emission. Corresponding experimental reports suggest a change of reaction rates and a change of reaction products compared to conventional expectations. Nonradiative excitation transfer among coupled quantum systems is a known mechanism that can account for the majority of anomalies. The basic principle is that the emission of energy from a reaction -- such as a fusion reaction -- is accelerated through the resonant absorption of released energy by a nearby acceptor system. Secondary reactions can then lead to a range of different reaction products. Such energy transfer requires the enhancement of ordinarily weak couplings between nuclei, as enabled by collective effects related to superradiance.

We seek quantitative agreement between this theoretical picture and experiments that exhibit anomalies. However, samples used in such experiments are complex and often incompletely characterized, posing challenges for modelling efforts. Our approach in recent years has been to work with conceptually simpler experiments focused on the above-described mechanism, ideally under conditions where all relevant physical parameters can be controlled. In these experiments, the transfer of excitation from one Fe-57 nucleus to another can be much faster than the decay rate, resulting in an externally induced modification of the natural decay scheme.

In Fe-57, the lowest excited state at 14.4 keV is coupled to the ground state via the magnetic dipole interaction, which allows for quantitative models for excitation transfer in the presence of an externally driven oscillating magnetic field. If the magnetic field is uniform over many nuclei, then excitation transfer is enhanced by cooperative Dicke factors, which greatly increase the transfer rate. Destructive interference is reduced due to shifts of the nuclear energy levels off of resonance.

The fastest excitation transfer rates are predicted for Dicke state to Dicke state transfer, originating from an initial delocalized state of collective nuclear excitation. This motivates an experiment where large-scale delocalization of gamma emission is produced by excitation transfer across a single-crystal sample. An initial Dicke state can be produced by synchrotron excitation. For experiments in which initially localized excitation is produced following the electron capture decay from Co-57, stronger couplings are need to yield comparable effects. In such experiments, strong internal oscillating magnetic fields capable of mediating excitation transfer can be obtained through spin wave excitation.

MHE Reactions in New Experiments by D-System

Masahiko Hasegawa[1], Akito Takahashi[1], Yutaka Mori[1],Yuichi Furuyama[2]

[1] Technova Inc., 100-0011 Japan,

[2]Graduate School of Maritime Sciences, Kobe University, 658-0022 Japan,

E-mail: hasegawa@technova.co.jp

We have proceeded to increase the AHE (anomalous heat effect) power by the MHE (nano-metal hydrogen energy) reactions, to clarify the main factors for the MHE mechanism and to verify them by experimental data. The new MHE evaluation equipment (so-called D-system) was designed to adjust the higher excess heat power (Wex [W/kg _sample] is over 200) at high temperature region, to grasp the AHE generation phenomena and to verify the MHE reaction mechanism. The main points of improvement from the previous C-system [1)] are as follows;

a) Heat recovery system by radiation heat transfer to cover temperature higher than 400°C of the sample in the reactor.
b) Additional temperature sensors to get more precise data of the phenomena in the reactor
c) The shape of sample loading zone in reactor to homogenize the temperature distribution in the reactor.

As the results, it was confirmed to execute data for the evaluation up to high temperature (up to around 900 degree C) with smaller temperature variation inside reactor. It became clearer to observe the temperature dependence to the MHE reaction.

Further, the close correlation of excess heat-power and hydrogen loading ratio (H/Ni) was clearly confirmed. These are the evidence data for the MHE reaction mechanism. This time we have shown two typical reaction processes. Used MHE sample was CNZ-type one (Cu_1Ni_7/zirconia, 140-150g, repeated calcination). The actual excess heat power level were 25-35W (Wex=200-280 W/kg _sample). The H/Ni loading ratio was calculated from the pressure decrease of reactor chamber and hydrogen reservoir tank, Pr and Ps respectively.

The first characteristics of reaction process is that rapid hydrogen absorption starts just after the heater input, and the heat generation peak happens following heat absorption by H-loading in some minutes. After passing around H/Ni =1.0, the main power plateau of Wex continued for several tens hours. The second characteristics of reaction process is that H/Ni loading ratio proceeds to increase very slowly for a few days(30-70h) up to the saturation of H/Ni>>1.0, then Wex starts to decline and stabilizes to be steady and stable, and continues for long time. The detail situation of these phenomena are dependent on the condition of heater input power variation, namely temperature height of MHE sample.

These characteristics are the verifications data for the already reported mechanism between the MHE reaction and the hydrogen absorption into the pseudo-lattice of Cu-Ni nano-composite particles. Regarding the detail, we will show by another paper in this ICCF24 conference[3)]

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This is abstract to paper for ICCF24 Conference, USA, July, 2022

Microscopic Insights into the Anomalous Heat Effect that Unify Disparate Experimental Results

Graham K. Hubler
The Medical School, University of Missouri, Columbia, MO USA
hublerg@umsystem.edu

The anomalous heat effect (AHE) has many embodiments including hydrogen loading by electrolysis, high and low hydrogen pressure over elevated temperature nanostructures, ultrasound, and glow discharge. The AHE was triggered by variable charging current, temperature fluctuations, high voltage pulses, laser pulses, ultrasound, and just time. Pd materials for which the AHE has been reported include wires, rods, foils, and nanoparticles. Ni materials for which the AHE has been reported include Nichrome wires, Ni in zeolites, and Ni nanostructures. It is highly likely that the same AHE mechanism underlies all these embodiments despite their seemingly wide differences. Many investigators involved in research on the anomalous heat effect, including this author, are of the opinion that phonons in Pd and Ni play a role in generating and sustaining the AHE. In this talk, I demonstrate how one assumption, coupled to several recent experimental results, can lead to useful microscopic insights that unify disparate experimental results under one umbrella and that may also be useful to guide further experiments.

The ideas that led to this model came from 40-year-old internal friction data on PdH[1], recent x-ray diffraction data on superconducting palladium hydrides[2], and perturbed angular correlation (PAC) results on palladium hydrides recently obtained by this author at CERN[3]. *Simply posited, the AHE requires a specific frequency optical phonon resonance that couples to electromagnetic radiation of the same frequency. If it can be arranged to sustain this specific resonance, then the AHE is produced.*

The phonon resonant frequency in PdD_x is a complicated function of the D concentration (cannot get right frequency with H), defect concentration of the right type, interstitial site occupancy (fraction of octahedral vs tetrahedral), temperature, polycrystalline texture, surface micro-topology. To obtain the goal of an AHE result, one must manipulate the material so that it resonates at this unique frequency. Once triggered, the AHE mechanism itself produces either the right frequency phonon or the right frequency electromagnetic radiation that provides *the positive feedback to sustain the AHE mechanism*. Experiments using Pd are run near the Pd Debye Temperature and so phonons are part of most excitations in the solid. For Ni, experiments are run at elevated temperatures that exceed the Debye temperature where phonons are not possible. However, the boundary conditions extant in nanostructured materials recover the ability of Ni-based materials to support phonons at elevated temperatures. *This specific resonance-phonon model is agnostic as to what the actual AHE mechanism is.* Examples will be given to show that essentially all methods that have been used to coax out the AHE fit under the umbrella of this phonon-resonance model. Suggestions for further research implied by this model will be discussed.

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Analysis of Photon Radiation for Spontaneous Heat Burst Phenomena during Hydrogen Desorption from Nano-sized Metal composite

Takehiko Itoh[1,2], Yoshinobu Shibasaki[2], Jirohta Kasagi[1]
Tomonori Takahashi[2], Shinobu Yamauchi[2] and Yasuhiro Iwamura[1]

[1] Research Center for Electron Photon Science, Tohoku University, 982-0826 Japan
[2] CLEAN PLANET Inc., 105-0022 Japan
E-mail: itoh@lns.tohoku.ac.jp

We have been conducting research on anomalous excess heat (AEH) generation phenomena using hydrogen and nano-sized metal composite. Up to the present, we succeeded in observing the AEH that cannot be explained by the chemical reaction [1,2,3].

The experimental process is as follows. The sample used in the experiment is a Ni/Cu nano multilayer film which was deposited on Ni substrates by sputtering. First, the two films are fixed on both sides of a ceramic heater in a sample holder installed in the vacuum chamber. Next, the samples are sufficiently baked out in a vacuum, and then H_2 gas is introduced into the chamber to 200 Pa, the heater temperature is kept at 250 C for about 15 hours to allow the samples to absorb hydrogen. Finally, we heat the samples up and keep the heater input power constant, while evacuating the chamber to release hydrogen from the samples: This induces the AEH generation. In these experiments, we often observed heat burst phenomena, in which the temperature of the heater suddenly rises [2]. Observing this phenomenon in detail is one of the ways to understand the mechanism of the AEH production.

Recently, experiments have been conducted by adding light radiation to temperature measurement [4,5]. We measured the heater temperature continuously together with the light radiation emitted from the surface of the sample. Attempted was the simultaneous detection of light radiations when the heat burst occurred. Used photodetectors are TMHK-CLE1350 (wavelength 3-5.5 μm) for mid-IR, an FTIR spectrometer Hamamatsu C15511 (1.5-2.5 μm) for near-IR, and a spectroscope Hamamatsu C10027 (0.3-0.9 μm) for visible light.

It was found that the radiation intensities of visible light, near-infrared light, and mid-infrared light increased in synchronization with the occurrence of heat bursts as reported in [5]. Analysis of the radiation intensity spectra in a wide energy region is decisive in the consideration of the reaction mechanism, for example, hotspot formation [6]. Thus, the analysis of the spectra during heat bursts was continued, and the following became clear: In normal thermal radiation, the observed spectrum is consistent with the one calculated by the gray-body radiation model. On the other hand, the spectrum at the time of the heat burst shows a slight difference from the gray-body radiation spectrum in high energy region (near infrared to visible light region). Details of the results and analysis will be reported.

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Anomalous Heat Burst Triggered by Input Power Perturbations observed in Ni-based Nanostructured Thin Films with Hydrogen

Y. Iwamura[1], T. Itoh[1,2], T. Takahashi[2], S. Yamauchi[2], M. Saito[2], S. Murakami[2], J. Kasagi[1] and T. Hioki[2,3]

[1] Research Centre for Electron Photon Science, Sendai, Japan

[2] CLEAN PLANET Inc., Tokyo, Japan

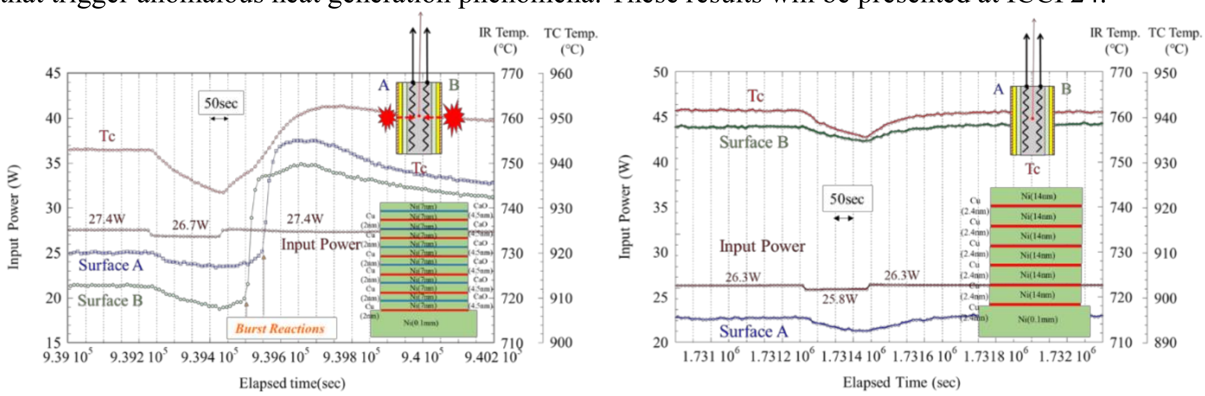
[3]Institutes of Innovation for Future Society, Nagoya University, Nagoya, Japan

Email: iwamura@Lns.tohoku.ac.jp

We have been studying anomalous heat generation phenomena caused by the interaction of hydrogen with Ni-based nanostructured Cu and Ni multilayers. Our experimental method is to induce anomalous heat generation by absorbing hydrogen into the Ni-based multilayers, exhausting the hydrogen, and then rapidly heating the sample with a heater. We found heat generation phenomena that cannot be explained by known chemical reactions (at least 10 keV per hydrogen atom). The amount of released energy varies depending on the structure and composition of the multilayer film [1].

As we repeated the experiments, we noticed that occasionally spontaneous heat burst phenomena occurred [2]. By investigating observed spontaneous heat burst phenomena in detail, we succeeded in intentionally inducing a heat burst phenomenon by perturbating the heater input power. The heater centre temperature (Tc) and the surface temperature of the sample were measured in experiments. Figure 1(a) shows an example of a heat burst induced by an intentional input perturbation, and (b) shows an example of a heat burst that did not occur even after a similar input perturbation. After perturbation in input power, the red Tc and green and blue surface temperatures increased significantly in (a) but remained the same in (b) as in the beginning. A sample of $CuNi_7$ multilayer with CaO and a sample of $CuNi_{5.8}$ multilayer were used in (a) and (b), respectively. The energy released by a heat burst phenomenon was larger than known chemical reactions such as the reaction between the sample and residual gas in the chamber.

Experiments and analysis are underway to investigate under what conditions the anomalous heat generation reaction can be triggered. By modelling the heat burst phenomena, we are trying to elucidate the mechanism by which the anomalous heat generation phenomenon occurs. At the same time, we are also conducting various elemental analyses such as SEM-EDX and TOF-SIMS to clarify the conditions that trigger anomalous heat generation phenomena. These results will be presented at ICCF24.



(a) (b)

Figure 1. Different responses of sample surface and heater center temperature to input power perturbations: (a) An example of heat burst by an intentional input perturbation, (b) An example of no heat burst by a similar input perturbation.

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Comparison of excess heat production in NiCu multilayer thin film with H_2 and D_2 gas

J. Kasagi[1], T. Itoh[1,2], Y. Shibasaki [2], T. Takahashi[2], S. Yamauchi[2] and Y. Iwamura[1]

[1] Research Center for Electron Photon Science, Tohoku University, 982-0826 Japan
[2] CLEAN PLANET Inc., 105-0022 Japan
E-mail: kasagi@lns.tohoku.ac.jp

The composite metal multilayer thin foil, developed by Tohoku U. and Clean Planet Inc., is extremely effective in generating huge heat generation, much larger than that produced in chemical reactions. [1,2] The NiCu 6 bi-layered film deposited on Ni substrate, which has absorbed hydrogen gas, generates anomalously large excess heat during desorption. The method is superior as indicated below, and, thus, expected to be a useful means not only for research on practical application of heat generation but also for unraveling unknown physics: The amount of generated energy can be evaluated for many samples with various combinations of materials and their thickness thanks to relatively easy preparation of a sample, and the measurement of the correlation between heat generation and radiation emission (not only photons but also charged particles) can be performed without difficulty since the sample is placed in a vacuum.

Here, we report on the result of asking how much the amount of generated energy differs between the case of using hydrogen gas and that of deuterium gas. In a very early experiment for Pd and heavy water, it was recognized that the d+d reaction is the elementary reaction of the heat generation, and the experiment with Pd and light water was treated as a control experiment in which heat generation did not occur. However, after that, when Ni is used as a sample material, heat generation has been reported even with light water (or with hydrogen gas). Therefore, comparing the results using hydrogen gas and deuterium gas is extremely important for considering the elementary process of the reaction.

For the experiment, used was the photon detection chamber with which light radiation emitted from the sample is detected over a wide range in wavelength, as reported in [2]. Extensive spectral measurements of light radiation provide visual evidence of generated heat power. One can see such an example in Fig. 1, which compares the three spectra measured with H_2 (blue dots), with D_2 (red dots) and without gas (black dots) in the NiCu thin film sample heated by the input power of 34 W. The radiant intensity ($Wcm^{-2}sr^{-1}eV^{-1}$) is plotted against photon energy (eV); the inserted graph shows a linear-scale plot of vertical axis. As can be seen, the observed intensity is almost the same for the gas is hydrogen (blue) and deuterium (red). Moreover, they are greatly enhanced over the black dots (without H and D) in all energy region. From the direct spectral comparison, one can simply conclude that the amount of the excess power is almost same with H_2 and D_2.

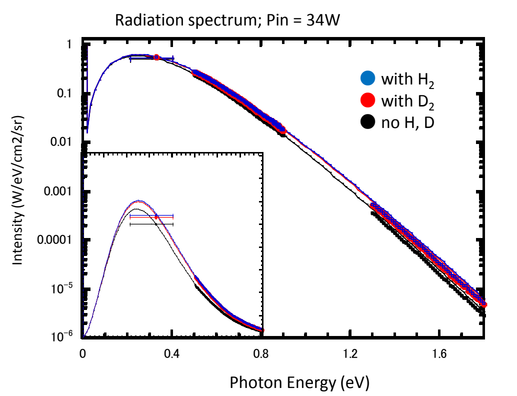

Fig. 1. Comparison of photon radiation spectra.

We will show experimental details, quantitative analysis based on the heat flow model and discuss on the elementary process of the reaction.

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Water Plasma Vortex Reactor and Obtaining of Extra-Thermal Energy and Transmutated Chemical Elements

Klimov A. [1], Altunin S. [2], Kulikovskii O.[2]
[1]Moscow Power Engineering University, Russian Federation
[2] Technical Centre "Prometheus", Russian Federation
Email: klimov.anatoly@gmail.com

Water Vortex Plasma Reactor (WPVR) was designed, manufactured and tested at the first time. Large background obtained in plasma aerodynamics, plasma-assisted combustion and LENR physics in our Lab was used for designing of this reactor. This work is continuation of the previous ones [1-4]. Water vortex flow was used as a fuel (hydrogen atom and ion creation by electric discharge) and a water heat exchanger in this setup simultaneously. Pulsed repetitive electric discharge was created inside argon vortex core in the WPVR. Electrodes from nickel (and other metals) were used in this reactor. Experimental variable parameters were the followings: - water flow rate, argon flow rate, distance between electrodes, electrode's material, electric pulse parameters. It was revealed that there is optimal very stable operation regime of this WPVR with a high value COP ~3-4. The value of extra heat power in this operation regime was about of 2-3 kW. Self-sustained relaxation oscillations of current and voltage were realized in this stable operation regime. It was revealed that there are many new transmutated chemical elements in the water sediment. There are light chemical transmutated elements (such as carbon, aluminium, silicon, sulphur and others) and heavy ones (such as cuprum, zinc, ferrum and others) in the sediment sample. Chemical analysis of these sediment dusty particles was obtained by EDS method, optical spectroscopy and soft X-ray spectroscopy. Direct electrical power extraction from a heterogeneous plasmoid created by pulsed repetitive electric discharge in the WPVR is considered in this work. Results of measurement of neutron flux and soft X-ray radiation from heterogeneous plasmoid created in this reactor are discussed in this work also.

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XRD and PAS investigations of deuteron irradiated zirconium samples

#A. Kowalska[1], M. Valat[2], M. Kaczmarski[2], J. Baranowska[3], J. Slowik[3], K. Czerski[2], R. Dubey[2], N. Targosz-Ślęczka[2]
[1] Institute of Mathematics, Physics and Chemistry, Maritime University of Szczecin, Szczecin, Poland
[2] Institute of Physics, University of Szczecin, Szczecin, Poland
[3] Materials Engineering, West Pomeranian University of Technology, Szczecin, Poland
#Email: a.kowalska@am.szczecin.pl

LENR phenomena are known to be extremely dependent on the local crystal structure and crystal defects of the deuterated samples. This has a strong influence on both hydrogen diffusion and the effective electron mass. The latter determines the strength of the local electron screening effect [1] and can change the deuteron-deuteron reaction rates at thermal energies by many orders of magnitude [2].

In the present study, Zirconium samples were exposed to various conditions and energies of deuteron beams using the unique accelerator system with ultra-high vacuum, installed in the eLBRUS laboratory at the University of Szczecin [3]. Irradiated and virgin samples were investigated by means of the X-ray diffraction (XRD) and positron annihilation spectroscopy (PAS) [4]. Whereas the first method delivers information about changes of crystal lattice parameters and possible production of hydrides [5,6] accompanying the formation of dislocations that are produced during irradiation of the samples, the second one can determine the depth distribution of crystal defects, being especially sensitive for vacancies.

Both investigation methods show structural changes of the Zr samples. The number of vacancies produced by deuterons are comparable to that observed by carbon or oxygen irradiations. The target structure modifications at the surface of the samples could be also confirmed by the scanning electron microscopy (SEM). The presented diagnostic methods will be applied in the future studies to correlate the number of crystal defects and changes of crystallographic parameters with the increase of the deuteron-deuteron nuclear reaction rates.

The study is part of the CleanHME project. This project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 951974.

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Trends in transmutation products and hydride formation in Brass, Bronze, Solder and Silver Brazing alloy cathodes during light water electrolysis

Monu Kumawat,[1] Mayank Nagar,[2] Ankit Kumar,[1] Shyam Sunder Lakesar,[1] Harishyam Kumar[1], Kaanapuli Ramkumar[1], Raj Ganesh Pala,[2] Pankaj Jain,[3] K P Rajeev.[1]

Department of Physics, Indian Institute of Technology Kanpur, India[1]

Department of Chemical engineering, Indian Institute of Technology Kanpur, India[2]

Department of Space Science and Astronomy, Indian Institute of Technology Kanpur, India[3]

monuk@iitk.ac.in,[1] mayank@iitk.ac.in,[2] ankt@iitk.ac.in,[1] sslake@iitk.ac.in,[1] rpala@iitk.ac.in,[2] pkjain@iitk.ac.in,[3] kpraj@iitk.ac.in,[1]

Recently multiple light water (H_2O) electrolysis experiments have produced significant elemental transmutations in various metal cathodes. [1-3] The alloy cathodes have shown better efficacy compared to pure metals in initiating transmutations. The presence of an upper bound (in terms of atomic number) is also observed in the transmutation products. [3] In light of the effectiveness of certain alloys in facilitating transmutation and eliciting a distinct upper bound in fusion products [3], in the present work, we seek generalizable trends by exploring a wider set of alloys. Specifically, we report various experiments in which Brass ($Cu_{0.52}Zn_{0.23}O_{0.05}C_{0.20}$), Bronze ($Cu_{0.66}Sn_{0.14}O_{0.10}C_{0.10}$), Solder wire ($Pb_{0.46}Sn_{0.27}As_{0.07}S_{0.01}O_{0.05}C_{0.14}$) and Silver brazing ($Ag_{0.75}Cd_{0.05}Cu_{0.10}O_{0.05}C_{0.05}$) cathodes have been used in two-electrode light water electrolysis (~30 Volt DC, 2-3 Ampere,10-15 hours) to study transmutations and possible hydride phase.

Special emphasis was paid in choosing graphite as anode in all of our experiments to rule out possible anode material contamination on the cathode. Energy-dispersive X-ray spectroscopy (EDS) is used for the characterization of electrodes before and after electrolysis. The EDS analysis shows that in the silver brazing rod, Cd vanishes and significant production of Fe is observed. Fe produced is the upper bound in the case of a silver brazing rod. In solder wire electrolysis, Cu is produced and is also the upper bound. Notably, production of iron (Fe) is observed in both brass and bronze with a decrease in Cu weight percent, although Sn weight percent decreased remarkably compared to Cu in bronze. Again, Fe is the upper bound in the case of brass and bronze.

Electrolysis leads to the cathodic loading of H and hence allows the study of various metal-hydride systems important for LENR.[4] Therefore, parameters like current, voltage and the kind of electrodes used to produce a particular transmutation are of immense importance to LENR experiments and its mechanistic rationale. An important goal of this work is to explore if there is a correlation between transmutation and electrochemically produced metal-hydride phase. In addition, we also contrast transmutation products obtained via a steady DC voltage against those obtained via periodically varying voltage, which leads to a localized "glow" and hence, higher local temperatures at the cathode.

All the experimental results reported above may play important roles in a proper understanding of LENR.

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Cut-off Voltage for Transmutation in Light Water Electrolysis

#Shyam Sunder Lakesar[1], Ankit Kumar[1],Monu kumawat[1]
Harishyam Kumar[1], Kanaapuli Ramkumar[1], Raj Ganesh Pala[2],Pankaj Jain[3],K P Rajeev[1]
Department of physics, Indian Institute of Technology Kanpur, *India*[1]
Department of Chemical engineering, Indian Institute of Technology Kanpur, *India*[2]
Department of Space Science and Astronomy, Indian Institute of Technology Kanpur, *India*[3]

sslake@iitk.ac.in, *rpala@iitk.ac.in*, *pkjain@iitk.ac.in*, *kpraj@iitk.ac.in*

Electrolysis aimed at hydrogen and oxygen evolution is performed at less than 2.5 V where electrodes show no elemental transmutations on cathodes involved [1]. In contrast, various experimental papers confirm transmutation at cathodes involved in a high bias (30-40 V) two-electrode system[2]. In the light of the above-mentioned studies, the current-voltage value-driving electrolysis seems to act as a threshold/transition point above which nuclear transmutation is observed and below which it is not.

We report experimental results on such transition voltage/current values for observing transmutations in our electrolysis experiments. We perform electrolysis with a two-electrode setup via graphite anode and nickel (Ni) cathode (99.5% trace metal analysis). All the other experimental parameters like electrolyte and its concentration (1M K_2CO_3 aqueous solution), the surface area of electrodes dipped in the electrolyte, the separation between the electrodes, etc are kept constant in all the experiments. The variable in the experiment is the driving Voltage (5 to 40 V_{RMS} in steps of 2.5 V) of a bridge rectified power supply. All the cathodes are characterized before and after electrolysis via Energy dispersive spectroscopy (EDS). Obtaining a clear threshold voltage parameter for transmutations is the novelty of the paper and will serve as an essential milestone for the field of electrochemical activated nuclear reactions to further its mechanistic underpinnings.

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Advances in Understanding Cluster type Reaction Sites

George H Miley and the UIUC LENR Research Group
Nuclear, Plasma and Radiological Engineering Department
University of Illinois, Urbana, Illinois 61821
ghmiley@illinois.edu

The author and colleagues have studied the formation of" clusters" of hydrogen/deuterium atoms as the source for nuclear reactions in a variety of metallic electrodes. Due to the extremely high density of the cluster atoms, a variety of multibody reactions among cluster atoms as well as with neighbouring host metal atoms can occur. Therefore, the reaction products as well as the production of heat per unit volume can vary widely. Prior measurements of these phenomenon have been described in talks at earlier ICCF meetings. Measurements included showing the cluster sites became superconducting near zero degrees Kelvin. Also, the clusters per unit volume were shown to be dependent on the prior formation of dislocation loops and defects in the metallic electrodes. Further confirmation of cluster behaviour came from experiments using a petawatt laser to drive cluster atoms out of electrodes forming directed beams. This in turn allowed identification of separate beams from site locations.

Our initial studies used electrochemical type cells with multilayer thin metal coatings on ceramic electrodes. Repetitive loading/de-loading cycles were used to generated defects and corresponding reaction sites. Excess heat measurements were shown to correlate reasonably well with the number of loading/de-loading cycles up to a saturation point which set-in at 8-10 cycles. Saturation is caused by formation of overlapping defects. Our more recent studies have converted to either plasma implantation of ions into electrodes or pressurized nanoparticles to form clusters [1,2]. This selection simplifies operation at high temperatures, thus offering a higher conversion efficiency to electricity.

Several key issues remain relative to cluster type LENR reactions. We are continuing studies to further confirm the correlation between cluster formation and excess heat. A related issue is the run time, e.g., are clusters reformed as rapidly as they are removed by reactions. Our approach to studying these issues is to periodically remove electrodes from the experiment and preform a temperature-programmed desorption measurement. In this measurement the volumetrically absorbed hydrogen/deuterium is removed at lower temperatures while the cluster loaded gas is markedly observed to come out in the 600-800 degree C range. Results from these and related experiments will be presented at the conference.

Another issue with cluster LENR involves whether the cluster formation (e.g., size, shape, and number of atoms) affects the type of reaction that occurs. Some thoughts about this based on data from Ref [2] will also be provided.

Acknowledgment: Partial support for this research was provided by Industrial Heath. LLC

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Evidence of reproducible tritium production in a pulsed electrolytic cell

Fabrizio Righes [1], Giorgio Vassallo [2,#] Guido Parchi [3]

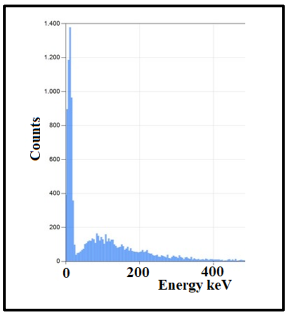
[1] Teralab, Italy
[2] University of Palermo, Italy
[3] FutureOn Srl, Italy
Email: guido.parchi@prometeon.it

Reproducibility has been for several decades the 1st major obstacle for a widespread acceptance of the existence of Low Energy Nuclear Reactions among the scientific community. A simple experiment capable of reproducibly generating elements or isotopes not normally present in nature, as tritium, would be an irrefutable proof of the possibility of low-energy nuclear transmutations. The importance of such an experiment could not be underestimated but, for various reasons, among which the difficulty of reproducing the phenomenon is the most important, some former tritium generation claims have not received the due attention. According to [1] "Tritium appears to be the least ambiguous and most easily measured product of the Cold Fusion effect".

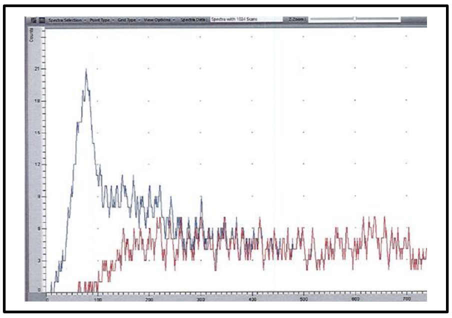
In this paper we present a relatively simple, low-cost experiment that clearly shows a reproducible generation of beta particles presumably produced by an unstable gas isotope like tritium, obtained with a Nickel wire immersed in light-water and opportunely solicited by intense, short electric pulses. The presence of Tritium in the electrolytic solution after each experiment has been confirmed by analyses performed by different laboratories.

The reproducibility of the experiments was gradually achieved after some years of trials which finally led to understanding the relative weight of the several variables that allow to start and to keep the reactions alive. The functioning of this innovative electrolytic cell is based on the discovery of the effects on matter, both in liquid and solid form, of a special kind of EM solitons.

This experimental result will be presented along with a preliminary hypothesis, based on the formation of ultra-dense hydrogen clusters, that may explain such surprising behaviour of the electrolytic cell.



Emitted gas - Photons energy spectrum.



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A technological foresight for the future deployment of different types of LENR energy sources

Franck Ballarano, Erick Braquet, Cyril Calatrava, Philippe Koehl, Jacques Ruer*
SART von Rohr, France
Email : jsr.ruer@orange.fr

Future LENR reactors will deliver heat utilized in the society and the industry. The reactors can be characterized by the temperature level of the heat source, the power density, the size and the mode of operation. Some energy feedback in the form of electricity may be required to activate and control the reactions. [1]
Different types of LENR reactors are defined according to the operation parameters [2]:

- Type 1: Reactors requiring external electricity for activation and additional heating
- Type 2: Reactors exporting heat but requiring external supply of electricity for activation
- Type 3: Self-sustained reactors with a heat engine generator exporting electricity
- Type 4: Direct generation of electricity

Type 2 differ from type 1 by the heat losses mainly influenced by the size of the reactor. Type 3 require a sufficient heat conversion efficiency. Type 4 are basically solid-state technology.
The thermodynamic analysis of the different types allows the comparison with the conventional sources of heat and power. It makes it possible to find out the applications domains where the new technology would be in competition with conventional ones and others where LENR sources would offer new opportunities. Although the precise features of the reactors nor the future costs are still unknown it is already possible to describe some potential applications where the new form of energy will provide valuable benefits.
An overview of the usages of the conventional energies in the society and the industry is presented in terms of temperature requirements and energy consumptions [3].
The double analysis is used to build scenarios to imagine the possible introduction of the different LENR types in the industry.
The deployment of LENR will be progressive. The prime market for each type will be different and unfold at different paces. Types 1 & 2 will be confined to small power ratings, the cost will decrease following the cumulated number of units produced. Type 3 units will first be utilized in niche applications where the absence of frequent refuelling will prove an important asset. The learning curve will allow a progressive augmentation of the unitary power and the clustering of units in large stationary generators.
If the LENR power density is low mobile equipment (automotive, trucks, airplanes, marine) will first be supplied via the use of LENR to provide an increasing fraction of the existing energy vectors like electricity for EVs, or near-future vectors like hydrogen and synthetic fuels without a breakthrough in the infrastructure for energy distribution.
At some point, movable LENR sources will become feasible provided the energy density is sufficient. Breakthrough technologies will be developed accordingly for moving equipment. Type 4 systems will likely make this revolution a reality.

The study is part of the Project CleanHME. This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 951974.

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The Nature of Cold Fusion
(Cold Fusion Made Simple)

Edmund Storms, United States
storms2@ix.netcom.com

The cold fusion process involves several conditions controlled by the chemical properties of a material. When the required but rare conditions occur, complex nuclear interactions involving any isotope of hydrogen become possible. The conditions consist of the formation of physical sites in a material in which a complex chemical structure involving hydrogen atoms can form, called the nuclear-active-environment (NAE). Once assembled, a novel interaction between the nuclei and electrons lowers the Coulomb barrier enough to make strong force interaction possible.

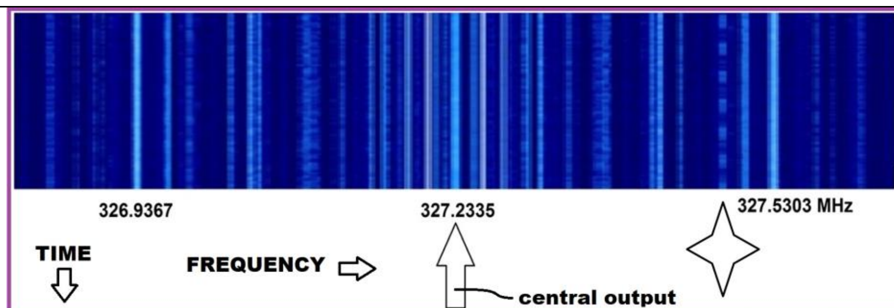
The energy is dissipated by ion, electron, and photon emission with insufficient energy to exit the apparatus. The major rate-controlling variable is temperature, which controls the rate at which the H or D can replace the nuclei that have been removed by the nuclear process. The activation energy for this replacement process is determined by how easily the H or D can get to the NAE. The creation of the NAE involves formation of nano-sized gaps in the physical structure mainly by stress relief. The greater the number of active sites and the higher the temperature, the greater the amount of generated power.

The formation of tritium, the weak emission of neutrons, the roles of both D and H, and the general observed behavior can all be explained by a logically consistent description. Although most details are still unknown, the need for a new understanding of nuclear interaction is required. Examples of the various aspects of the process are shown and described with the goal of making the process reproducible.

Synchronization of Vacancy-Loaded Deuterons Enables Successful LANR Mass-Energy Transfer

Mitchell R. Swartz, ScD, MD, EE AC1ER
JET Energy, Inc. Wellesley Hills, MA USA

Successfully driven lattice assisted nuclear reaction [CF/LANR] components emit unique very narrow-bandwidth hyperfine radiofrequency [RF] signals near the deuterium line [DL; ~327.37 mHz] along with informative sidebands and novel pulsations [1,2,3]. Their incredibly high Q heralds a large inverted population. Some of the pulsations (Figure, cf. star) appear coupled with periods of minutes; and when synchronized, may enable mass-energy transfer. In Ni and Pd vacancy-loaded deuterons are identical bosons, and thus can interact and interchange. This analysis requires equivariant bifurcation theory [4,5]. Mathematically, synchronization of the local deuteron oscillators in FCC vacancies smoothly proceeds to the "double Hopf bifurcation" driven by the applied electric field intensity. Of the many possible states which follow, only three solutions -- especially the "toroidal breather mode" [TBM] -- enable exchange of energy between the coupled oscillators. These important RF-detected LANR couplings, like those of the Huygens' clocks, interact in-phase with spatiotemporal symmetry. It is proposed that in LANR they combine as shown below. Most importantly, the TBM solution is the way by which interacting vacancy-loaded deuterons in highly loaded Group VIII alloys make moot and circumvent the need for surmounting the "coulomb barrier".

<table>
<tr><td>Pulsatile RF Emissions from an active LANR system [nickel hydrogen loaded LANR system; 40 volts, 200 mA] showing superhyperfine lines.
This 'waterfall' plot (time goes down) shows intensity as a function of frequency The arrow identifies the center line; the star identifies one pulsatile line.</td><td>
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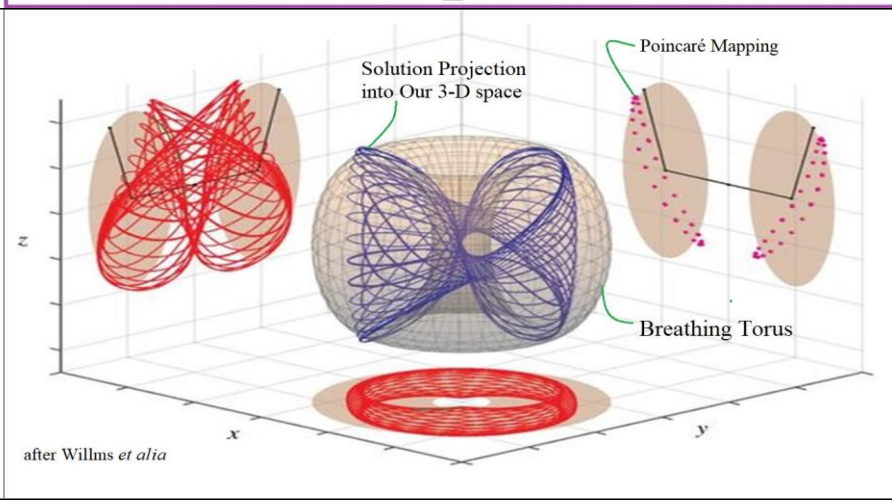
<tr><td>Synchronized Toroidal Breather Mode (TMB) As it Overcomes The Now Moot Coulomb Barrier - The blue central volume is the solution's projection into our own three dimensional space. The two planar projections are red, projected from the trajectory solution onto the left and bottom coordinate planes. The Poincaré map for y=0 is magenta, and is shown on the right coordinate plane as a one-dimensional (1D) closed curve. The breathing torus of the TBM is colored brown.</td><td>
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 e-mail: mswartz@nanortech.com

Understanding of MHE Power Generation Patterns by TSC Theory

#Akito Takahashi, Masahiko Hasegawa,Yutaka Mori

Technova Inc., 100-0011 Japan,

E-mail: akito@sutv.zaq.ne.jp

Using our new experimental system (called D-system [1]) of MHE (nano-metal hydrogen energy) reaction, it became able to measure and to evaluate more clearly the anomalous heat effect (AHE) by the elevated temperature interaction of nano-composite metal sample and hydrogen-gas. Two new characteristics of AHE excess power by the MHE reaction are reported [2]. After starting initial heating by W2 (100 -160W) heater, excess thermal power by MHE is steeply generated from around 300 degree C of CNZ-sample powder outer region temperature. Excess power suddenly starts to increase when H/Ni loading ratio reached at around 1.0. This timing is considered to be the time that H-loading at O-sites of Ni core becomes full to attain H/Ni =1.0 in about 20-60 minutes in our runs (Phase-1 process). After that turning point, relatively high excess power generation continues (for about 3 days) until the elapsed time region where H/Ni loading ratio saturates to be far greater than 1.0; H/Ni =2.2 was the saturated value in some run. This is the second phase H-loading by T-sites loading in Ni core: (Phase-2 process).

The main MHE power generation pattern can be explained by the nuclear energy release of 4H/TSC WS fusion events at T-sites of Ni nano-cores by dynamic 4H cluster formation of 4 protons moved from O-sites under phonon excitations in GMPW (global mesoscopic potential well) of Ni-nano-islands [3]. This is the major process of power (about 20W in our runs). In addition minor excess power (about 4 W) is considered being continuously released by 4H/TSC WS fusion events at SNHs (sub-nano-holes) on surfaces of Ni-nano-cores. This minor process remains after H/Ni ratio is saturated.

We found a method of MHE power re-activation by the RCV (reaction chamber valve) close-to-open method after H/Ni loading ratio becomes nearer to saturation [1]. When RCV is opened, pulse thermal power generation happens by 4H/TSC WS fusions at SNHs, which induces H-gas desorption-burst from T-sites of Ni-nano-cores. This trigger event produces empty T-sites in Ni-nano-cores and slow H-loading to T-sites restarts with relatively large generation of 4H/TSC WS fusion power (10-15 W) for considerably long time (about one day in our trigger-trial runs). This re-activation/trigger process can be repeated in-situ. We succeeded to trigger more than ten times. Prediction by the TSC theory seems working very well as briefly issued [3].

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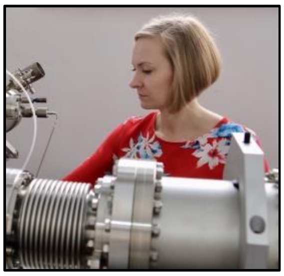
See also: (PDF) MHE nuclear-like thermal power generation and guiding TSC theory (researchgate.net)

This is abstract to paper for ICCF24 Conference, USA, July, 2022

Study of LENR with light nuclei in Zr and Ni based alloys using UHV accelerator



#N. Targosz-Sleczka [1], K. Czerski [1], R. Dubey [1], M. Kaczmarski [1], A. Kowalska [2], M. Valat [1]

[1] Institute of Physics, University of Szczecin, Szczecin, Poland
[2] Institute of Mathematics, Physics and Chemistry, Maritime University of Szczecin, Szczecin, Poland
email: natalia.targosz-sleczka@usz.edu.pl

The charged-particle-induced nuclear reaction cross section is a steeply decreasing function with lowering projectile energies. However, for nuclear reactions that take place in a metallic environment at sufficiently low energies, the observed cross section is enhanced. This is due to the screening of the charges of reacting nuclei by surrounding electrons of the medium in which the reaction occurs. It leads to the lowering of the Coulomb barrier, thus the penetrability through this barrier increases. Such cross section enhancement, called the *electron screening effect*, was firstly discussed for the dense stellar plasma [1], where due to the screening effect the reaction rates can increase by orders of magnitude compared to the reaction rates in the absence of screening [2]. The electron screening effect was theoretically predicted and experimentally confirmed during many investigations with different metallic targets [3-6]. Previously observed discrepancy between theoretical predictions and experimental results [7] could be explained thanks to precise ultra-high vacuum measurements performed for the $^{2}H(d,p)^{3}H$ reaction on Zr target at extremely low energies. The measurements enabled to distinguish between different contributions to the observed cross section enhancement resulting from the target lattice defects, the screening effect and the DD threshold resonance [8,9].

Considering the large quantity of different materials being studied for LENR, it seems substantial to introduce a simple method of quick estimation of the electron screening energy, allowing to determine the materials with perspectives of promising results in LENR. Here, we present our new method for such a recognition, developed for the accelerator-driven experiments. It is based on comparison between the experimentally measured $^{2}H(d,p)^{3}H$ reaction yields at two different projectile energies. The method has been applied to estimate the screening energies of Zr and Ni based alloys studied with deuteron beam at energies ranging from 8 to 20 keV.

The study is part of the CleanHME project. This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 951974.

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Self-similar mechanism of repeatedly flashing LENR in a magnetized partially ionized gas (warm plasma)

#V. I. Vysotskii, M. V. Vysotskyy
Taras Shevchenko National University of Kyiv, Kyiv, 01601 Ukraine
vivysotskii@gmail.com

Traditional methods of substantiating the mechanism of nuclear reactions at low energy are based on three basic concepts:
a) controlled change in the critical characteristics (heating or acceleration) of the interacting particles;
b) purposeful change in the characteristics of the near environment of the material media in which the interacting particles are located (compression, imposition of a changing magnetic field, change in the density of the electron or muon environment, change in the phase or physical volume);
c) hypothetical (physically unjustified) short-term change in the charge state of the proton due to its transformation into a neutron by weak interaction, which solves the problem of the Coulomb barrier.

In this paper, for the first time, an effective mechanism of self-similar stimulation of LENR is considered, which is realized in the process of natural multiple alternation of the processes of ionization of atoms and recombination of ions in the composition of a warm magnetized plasma. Each of the repeatedly ionization acts corresponds to the rapid activation of the mechanism of quantized motion of the formed ion in a magnetic field H, which corresponds to the pulsed $(\Delta t \approx \sqrt{M_i / 4\pi n_e e^2})$ excitation of a quantum oscillator with a frequency $\omega = eH / M_i c$. Such a regime leads to the automatic formation of a coherent correlated state of this ion with a correlation coefficient $|r| \to 1$ and to the generation of giant fluctuations of the momentum and kinetic energy $\delta E \geq kT / (1 - r^2)$ of these ions, the amplitude of which exceeds the thermal energy of these ions $kT \approx 1 \div 5\ eV$ by a factor of 10^4–10^6 [1,2]. It was shown that the duration of the process of formation of such states does not exceed the value $1/\omega$, and the duration of their existence corresponds to several periods of ion-ion collisions. At this stage, effective nuclear fusion takes place with the participation of such temporarily "hot" particles and other plasma particles - e.g, deuterons in the $p + d = He^3$ reaction in a weakly ionized magnetized hydrogen-deuterium plasma.

The subsequent evolution of ions in a low-temperature plasma leads to their very fast recombination into the state of neutral atoms. These atoms after a short time turn into ions again with the activation of the mechanism of automatic formation of a coherent-correlated state in an external magnetic field and the subsequent rapid formation of "hot" ions and LENR. Estimations show that in a partially ionized plasma with a density $n \approx 10^{16} cm^{-3}$, about $10^6 \div 10^8$ cycles of flashing LENR are possible every second for each of the atoms (protons or deuterons). The considered mechanism leads to the possibility of quasi-continuous generation of giant fluctuations of kinetic energy during the entire time of existence of a magnetized weakly ionized plasma and differs fundamentally from the previously considered methods for the single realization of such fluctuations.
A similar mechanism is also realized for many-electron atoms with a corresponding frequent switching of the multiplicity of ionization and recombination.

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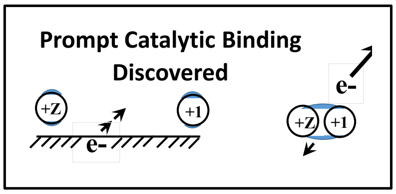
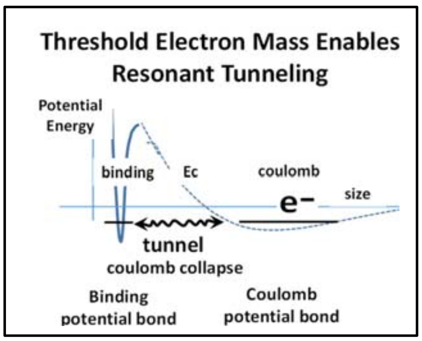
Electron Quasiparticle Catalytic Binding in Chemical Reactions with a Proposed Nuclear Analogy

#Zuppero, Anthony [1], Dolan, Thomas [2], LaRue, Jerry [3]
[1] Tionesta Applied Research Corp, USA
[2] Univ. of Illinois at Urbana, USA
[3] Chapman University, USA
Email: a.zuppero@theTionestaGroup.com

Chemical physics binding research at UC Berkeley and UC Santa Barbara in the 2000’s discovered a new ~ ½ cycle prompt electron catalytic binding reaction. This reaction process is being applied to LENR, revealing a way to bind nuclei at any temperature using heavy electron quasiparticles.



Experiments showed coulomb-repelling, binding-potential-attracting atoms and molecules can undergo prompt catalytic binding when an electron passes between them. These reactions are similar to muon catalysed fusion, except that in this case a single heavy electron quasiparticle absorbs binding energy so as to leave each reaction product in a low or ground vibration state.



Our model adds a general binding potential between two H_2+ ion reactants and varies the mass of the electron. We find that when electron effective mass exceeds a certain threshold a quantum tunnelling transition allows collapse from a coulomb potential bond to a binding potential bond. The above “Quantum Electron Catalysis” process, or QEC, can occur independent of temperature and even at zero Kelvin. Such QEC could therefore potentially control binding of highly reactive chemicals frozen on a cryogenic surface.

We derive the lowest effective mass an electron must have to act as a catalyst. The electron travels in the net-attraction region between positive reactants, allowing them to collapse toward it. Electrons with higher effective mass move more slowly. A sufficiently slow travel by an electron with over-threshold effective mass should attract reactants until they meet, and bind. The band structure determines the effective mass for non-interacting electrons. A delocalized electron is non-interacting at its unstable lattice equilibrium point, where all forces cancel. Therefore its effective mass may be used at that point. We propose a region near the point is sufficiently non-interacting. Reactants tunnel toward the electron during the ~ ½ cycle of three body vibration. When reactants meet they dump some or all the binding energy by moving or scattering the electron out from between them, leaving them bound.

This binding can be achieved by using heavy fermions, highly correlated electrons, or electron quasi particles. Methods used to increase the effective mass of an electron quasi particle are based on changing the band structure crystal momentum. These methods move electrons closer to band structure inflection points. Experimental methods to modulate crystal momentum include using surface acoustic waves, electrolysis, glow discharges, and other techniques involving hydrogen isotope diffusion, dissociation/recombination, and adsorption/desorption.

We propose that QEC could energize the first step of LENR by using the binding energy between a proton or deuteron and a lattice nucleus to deliver binding energy to third bodies within the effective region of the binding potential. For example, a newly forming nucleus may become internally excited with nearly the binding energy. Merging the discovery of resonant tunnelling caused by an electron quasiparticle with previously known chemical, nuclear and materials science provides a novel path to understanding LENR. Observed LENR properties that can be accounted for by QEC include reactant products born-in-the-ground state, synthesis of diverse isotopes, creation of fission products, and evidence of electron capture.

Poster Presentations

The predictive power of the Correlated- Coherent States model in LENR research: experimental results from p-Li reactions at low energy

#Sergio Bartalucci[1], Vladimir I. Vysotskii[2] and Mykhailo V. Vysotskyy[2]

[1]INFN Laboratori Nazionali di Frascati, Frascati, 00044 Italy
[2]Taras Shevchenko National University of Kyiv, Kyiv, 01601 Ukraine
E-mail: Sergio.Bartalucci@lnf.infn.it

The Correlated-Coherent quantum States (CCS) model [1-2] is described in this paper, showing its potentialities in the explanation of anomalous effects in Nuclear Physics and Astrophysics, such as excess energy production in LENR and the cosmological enigma of primordial lithium abundance[3]. The occurrence of nuclear reactions at very low energy is a clear indication of a strong enhancement of Coulomb barrier transmissivity, which has been observed in some crystal lattices at several accelerator facilities and is mainly ascribed to the classical electron screening mechanism. However, these experiments are downwards limited in energy ($E_{min} \geq 5$ keV) due to the strong electrostatic repulsion and a connection with room temperature experiments is impossible, due to the lack of effective theoretical ideas. The CCS model may allow this connection, according to an extensive literature [4-6]. A description of recent (pre-COVID) experimental test [7] of the CCS model predictions for the $^{7}Li(p,\alpha)^{4}He$ reaction is given in this paper at a c.m. energy around 450 eV, where the expected "standard" cross section is of the order of 10^{-50} barn! The detected α are unambiguously identified as coming from the above reaction and cannot be ascribed to background.
These results are compared to previous experimental findings [8], made by an independent team, which showed very high α-counting rates, but were erroneously interpreted by the authors thereby making further development impossible.
Some technical issues, which are related to this experiment are discussed and suggestions for improvement and planning of the next activity on this topic are also presented.
Potentialities of the CCS method for practical realization of a powerful energy source are also highlighted.

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Vacuum Capacitors for Energy Storage

#Jean-Paul Biberian[1], Michael Irgang [2] Roman Kholoshenko [2]
Jean-Philippe Ginestet [2]
[1] Aix-Marseille University, France
[2] Freel Tech, France
Email: jpbiberian@yahoo.fr

With LENR, the emphasis is placed on energy and more importantly electricity production. However, electricity production, is not sufficient, and in many applications, energy storage is of upmost importance. In this presentation, we will describe a novel method of electricity storage based on Vacuum Capacitors.

A Vacuum Capacitor is like a supercapacitor, but energy storage is achieved by using new physical principles. The Vacuum Capacitor can store charges (electrons) inside a small vacuum chamber, under high electrical field. We create the proper conditions to have these charges packed in very dense, cluster-like structures: the "charge clusters".

Hence, we achieve a volume storage, rather than a surface one (as with usual capacitors). Using charge clusters provides for a highly efficient and direct electricity storage, without transformation into electrochemical, or chemical energy. Moreover, with Vacuum Capacitors, charge and discharge can be achieved through a single electrode.

At the end of the 20th century, Ken Shoulders [1] [2] created a very original electronic device. He conducted experiments by sending ultra-short high-voltage pulses. He observed the creation of uncommon, localized charges (spherical form and hollow, with a diameter typically between 5 and 15 um), made of an accumulation of 10^8 - 10^{11} electrons. Ken Shoulders called these charge accumulations « Electrum Validum » (« EV », meaning « strong electron »), while their contemporary name is « Charge clusters » (or “Condensed Plasmoids”). He studied their behavior, lifetime, interactions with various metals, etc. Ken Shoulders made a great discovery in the field of high voltage electrophysics, while several other authors developed theories and wrote various publications about these exotic objects.

New energy transformations have been found using highly organized, micron-sized clusters of electrons (EV’s), having soliton behavior, with electron populations on the order of the Avogadro’s number. When interacted with solid material, these charge clusters perform a low-energy phase transformation type of atomic disruption that liquefies the lattice and propels the material to a high velocity without apparent signs of conventional heating.

We will show that in Vacuum Capacitors, large quantities of electricity can be stored several orders of magnitude larger than in conventional vacuum capacitors.

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Analogy Between the Properties of Spin Supercurrent and "Strange" Radiation Accompanying Low-Energy Nuclear Reactions

Liudmila Boldyreva, PhD, State University of Management, Moscow, Russia

The aim of this work is to show that the physical process of transfer of angular momentum - spin supercurrent - may be the process accompanying Low-Energy Nuclear Reactions (LENR). The existence of this process was predicted by Maxwell and experimentally it was investigated during the last fifty years, in particular, in superfluid ^{3}He-B [1]. Let us compare the properties of spin supercurrent [2] with the properties of "strange" radiation [3] based on the following properties of spin supercurrent. First, spin supercurrent emerges between virtual photons created by quantum objects, the value of spin supercurrent $(I_{ss})_z$ spreading along axis **z** proportionally to the gradient of virtual photons spins, $\mathbf{S}_v$, along axis **z**, expression (1): $(I_{ss})_z \sim \partial \mathbf{S}_v / \partial z$. Secondly, the virtual photon spin $\mathbf{S}_v$ is connected with spin $\mathbf{S}_q$ of quantum object creating this virtual photon and is moving at a speed greater than the speed of light, under condition (2): $\mathbf{S}_v \uparrow\downarrow \mathbf{S}_q$.

1) According to expression (1) the most probable is the emergence of a spin supercurrent in metals containing "free" electrons creating virtual photons with nonzero spin. It is in accordance with the properties of chemical elements involved in LENR (nickel, lithium, palladium).

2) It follows from expressions (1) and (2) that spin supercurrent is not spreading in a medium where $\partial \mathbf{S}_v / \partial z$ =0, that is, in a spin-polarized medium, for example, in a magnetized medium. This effect is observed in LENR.

3) The action of spin supercurrent changes the orientations of virtual photons spins between which it emerges and, according to expression (1), the orientations of spins of quantum object creating these virtual photons. Thus, electromagnetic radiation may emerge. This effect is observed in LENR.

4) According to expressions (1) and (2) the action of spin supercurrent results in a uniform orientation of spins $\mathbf{S}_q$, that is in magnetization of medium. This effect is observed in LENR.

5) As spin supercurrent transfers angular momentum, the tracks created by spin supercurrent on the surface of various materials have a vortex character. This phenomenon is observed in LENR.

6) As spins supercurrent emerges between spins $\mathbf{S}_v$ performing precession motion, the tracks created by spin supercurrent have a spiral form. This phenomenon is observed in LERN.

7) If spin supercurrent causes the contraction of the medium where it spreads and the speed of spin supercurrent is greater than the speed of spreading this contraction, then the action of spin supercurrents may result in appearance of periodically repeating jumps in density (according to some experiments [2] the speed of spin supercurrent may be grater than the speed of light). This property explains the emergence of twin tracks on the surface of various materials.

8) The spin supercurrent has nonelectric and nonmagnetic nature and consequently it does not shielded by electromagnetic screens.

The results of comparison of the properties of spin supercurrent with the properties of "strange" radiation allow us to conclude the following: the spin supercurrent may be the physical process which accompanies LENR and called as "strange" radiation.

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The scientific session. Theoretical and Computational Studies. **Presentation**: on-line.

The Electromagnetic Considerations of the Nuclear Force, Part III: An Analysis of the Electromagnetic Contributions to Nuclear Behavior

N. L. Bowen[1]
[1]Colorado Mountain College, Glenwood Springs, Colorado, USA
*corresponding author, email: nbowen@coloradomtn.edu

This paper is Part III of a series of papers [1], [2], describing the concepts of the Electromagnetic Model of the nuclear force—that force which holds together the nucleons in a nucleus. The Electromagnetic Model claims that the nuclear force is a direct result of the electromagnetic forces of the quarks within the nucleons. In this third paper, an analysis of configurations of the nuclides is determined by using the laws of electromagnetics. Previous nuclear theories have relegated the electromagnetic force as being a relatively minor component, considering only the Coulomb force of the protons.

With the understanding that quarks are the centers for both the electric charge and magnetic dipole moments within a nucleon, such outdated assumptions are no longer valid. Because of the strong electromagnetic interaction between the internucleon quarks, electromagnetism can, indeed, be the force that holds the nucleons together in an atomic nucleus. Thus, these changes in the understanding of the electromagnetic forces within the atomic nucleus require a more significant role of electromagnetism with regards to the understanding of nuclear behavior. Part III of this series of papers describes how the electromagnetic forces and energies affect the nuclear behavior. New insights and new understandings are gained by applying the laws of electromagnetics to the nuclear structure inside an atomic nucleus. In this paper, explanations of bond formation and bond breakage are given in detail, as well as how these processes relate to nuclear behavior.

This paper will discuss the subject of quarks and uncertainty principles, the electromagnetic energies within the nucleus, the various segments that comprise the nuclear structure, the process of bond formation, and the process of bond breakage, and how these processes affect the various nuclear decay modes and nuclear behavior

This model asserts that the electromagnetic properties of the quarks are what hold the protons and neutrons together in an atomic nucleus, binding the nucleons together with an internucleon quark-to-quark bond. Using the Electromagnetic Model, the ground state configurations of hundreds of atomic nuclides, from ^{2}H to ^{208}Pb, have been determined and computer simulated. The calculated binding energies agree with the experimental binding energies to within a few percent. These computations are done by using only one selected parameter. No previous theoretical model of the Nuclear Force has been able to demonstrate such an accurate prediction of binding energy with only one parameter, such as this model is able to achieve. This is an unprecedented success, and it strongly indicates the correctness of the Electromagnetic Model. The Electromagnetic Forces inside a nucleus, when fully considered, can explain many aspects about nuclear behavior.

This paper focuses on the Electromagnetic Forces, analyzing how they control and dictate the observable nuclear behaviors, when they are applied to the internal configurations of the atomic nuclides. In Part III of this series of papers, electromagnetic principles are used to analyze nuclear behavior. Numerous examples and calculations illustrate how the Electromagnetic Force, when applied to the quarks, affects nuclear behavior--behavior that previous nuclear models have been unable to solve. The laws of electromagnetics, as applied to the nuclear structure, are able to explain much about nuclear behavior. This model is able to explain many aspects of nuclear behavior with far more clarity than any previous model of the Nuclear Force. By understanding the Electromagnetic Forces within the atomic nuclide, and by applying these forces to the configurations of the atomic nuclei, a stronger comprehension of nuclear behavior can be gained. Thus, by identifying and recognizing the inherent structure within each nuclide, we can achieve more rigorous and accurate predictions of nuclear behavior. This, in turn, can give us a much better understanding of Low Energy Nuclear Reactions.

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Cold Fusion via Atomic Compression

Steve Casselman [1]
[1] Hotwright, USA

Email: sc (at) hotwright.com

The theory I propose is that there must be enough Pd atoms in a perfect crystal to absorb a fusion event. There also must be a condition that generates alpha-beta phase waves. Hydrogen is like water and leaks in at the most accessible place, which is the corners. As hydrogen is absorbed, it creates phase waves. This is like a Helmholtz oscillator. The same will happen when conditions are right for desorption. You can think of this as gas escaping from a balloon. It sets up a resonant oscillation. In cold fusion experiments, "excess heat" is generated after hours of hydrogen escaping. This sets up phase waves in the Pd.

Fleischmann and Pons started in 1983 self-funding their experiments. That means they probably used the same palladium targets charging and discharging them repeatedly. We now know from Dionne and Gray that bulk Pd will start to self-align and crystalize after repeated cycles. After many years they began to get results. They repeated the experiments with the same Pd targets and got repeatable results. They showed their results to the school administrators, who insisted they go public. They had annealed their targets and crystallized them over the years without knowing it. They released their finding, and others tried to repeat their experiments with no success. Not in the protocol was using the target sample maybe hundreds of times, thus creating the precisely aligned atoms that could all go from alpha to beta coherently and absorb the energy from a fusion event. When they got some money from the university and tried to recreate their experiment, they could not. No one could repeat their experiments.

People who set up the experiment with new bulk Pd got no results. No one comes in with bulk Pd and gets the results Fleischmann and Pons got, not even Fleischmann and Pons. But the search for cold fusion went on, and after a while, some researchers would get results. These results were not repeatable because to repeat the experiments exactly, one would have to work for years to load and unload their samples in a slow annealing process, allowing the Pd atoms to align internally into perfect crystals. The abuse that Fleischmann and Pons received was callous, and the fact that they could not repeat their own experiments with new targets must have been soul-crushing. Fleischmann searched for any reasons why this would be. He stated that the Pd must be cast and not rolled. Casting works better because casting usually entails a slow cooling process that creates seed crystals. This would allow crystals to grow big enough, after a time of slow annealing, to absorb the fusion event. I wonder if any of the original targets still exist? The one target that melted down was the cube, and this was because it had a 3D geometry that made it easier to create phase waves. The cube may also have been cut from a perfectly grown crystal.

Electron-electron bound state considering magnetic dipole-dipole interaction

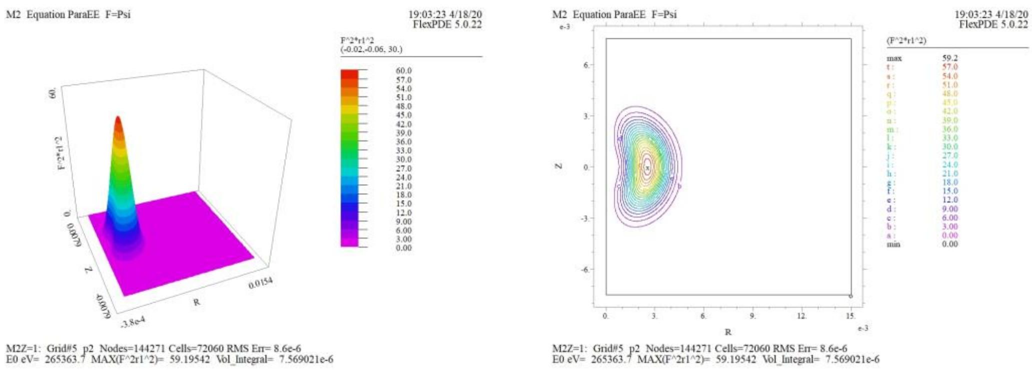
Arayik Emilevich Danghyan
Email: arayik@exhlab.com

Many publications discuss the problem of magnetic interaction between elementary particles with their own dipole moments. Basically, the magnetic interaction becomes significant at sufficiently small distances. Therefore, the problem becomes more complicated due to the need to consider relativistic effects. The equations obtained with the composite potential of the Coulomb and magnetic dipole-dipole interactions, in general, do not have a clear and straightforward analytical solution. This paper proposes an approach to study a particular case of electron-electron interaction by numerically solving the M2 equation [6].

Theoretical research has shown that when electrostatic repulsion and magnetic dipole-dipole attraction between two electrons happen simultaneously, this creates favorable conditions for forming an electron pair.

An electron pair is a toroidal entity with the following parameters: the binding energy of the ground state is equal to 265363.7 eV, the orbital radius is equal to 0.134793 pm (this is the distance between electrons), the total spin s = 1, and the magnetic quantum number m = 1.

During the formation of an electron pair, the total energy of 265363.7 eV is released in the form of one or several quanta. The number and energy of emitted quanta depend on the presence of excited states in the paired formation, in addition to the ground state. Such excited states have not been discovered theoretically yet. Depending on the experimental results, research in this direction will be continued.



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Direct Conversion of LENR inside Solid-State Fusion Diodes

Fabrice David
Laboratoire de Recherches Associatives
Email: laboratoire.de.recherches.associatives@orange.fr

The technology of “Fusion Diodes” makes it possible to transform the energy produced by the Low Energy Nuclear Reactions directly into electricity. Light, reliable, able to operate for long periods of time, LENR -powered Solid State Generators are the ideal sources of electrical energy for space applications. The absence of moving parts makes Solids States Generators with Fusion Diodes particularly reliable. The author also report the results of their replication experiments of Gas Fusion Diodes or “Lattice Energy Converters”.

The fusion diodes could be used to power the on-board electronics, but also ion thrusters. They can be used in deep space where solar panels are unusable.

The new physical phenomena discovered during the study of the properties of hydrogen isotopes in alloys will also make it possible to build new space propulsion devices with high specific impulse.

Latest results are presented.

HIVER Electrochemistry
Energy Produced Nuclear Tracks

Carl Gotzmer[1] ,Oliver Barham[1], Lou DeChiaro[1]
[1] Naval Surface Warfare Center Indian Head Division

Email: carl.gotzmer.civ@us.navy.mil

Email: oliver.m.barham.civ@us.navy.mil

Between 2019 – 2021, Naval Surface Warfare Center Indian Head Division (NSWC IHD) led a team of government, academic, and private industry partners in evaluating claims of cold fusion in literature, based on the 2013 patented Navy procedure[1]. A poster presentation at the ICCF-24 meeting provides a brief one-slide history of cold fusion for the benefit of the general audience, and focuses on the results in CR-39 solid state nuclear track detectors from a recent DARPA supported project on this topic conducted at NSWC IHD.

This is the first public NSWC IHD discussion of detected nuclear tracks and presentation of photographic results in poster format. Nuclear results include evidence of MeV-energy particles in CR-39 solid-state nuclear track detectors and other anomalous results to be presented by Oliver Barham in the ICCF-24 oral paper presentations.

The poster will also address a wider need to publish papers on this topic in top peer-reviewed mainstream journals. For example, the *Nature* family of journals has published positive low-energy nuclear reactions (LENR) results as far back as 1989[2], and more recently[3], and would be a good candidate family for LENR researchers to target.

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Any Independent Replications of the Holmlid Effect??

Kjeld C. Engvild
DTU Environment, Roskilde, Denmark
Email: kjeld.engvild@gmail.com

Over more than 10 years Holmlid and his group have published experiments [1-5], where they fire Nd-YAG laser pulses (532 nm, 300 mJ, 5 µsec duration, 10 Hertz) at deuterium close to or absorbed on a potassium promoted iron oxide catalyst (normally used for styrene production) to induce Coulomb explosions. Using time of flight measurements, they observe particles in the MeV range. Holmlid suggests that the catalyst promotes the formation a "D(0) state" which is a chain cluster of D's with a D separation of 2.3 picometer, only $1/30^{th}$ of the separation of D's in a deuterium molecule [4]. In later experiments Holmlid and Olafsson have observed muons, primarily based on deduced half-life [5]. The experiments have been repeated by Zeiner-Gundersen and Olafsson, working closely with Holmlid [6].

I have great difficulties in believing in the D(0) state, because electrostatic repulsion would break the cluster up at once. Also, D's so close together should fuse immediately, and the whole thing would explode. Perhaps other models might be possible?

The important thing is: Is the Holmlid Effect real? Replicating the experiments requires quite sophisticated equipment, such as a time-of-flight mass spectrometer. However, it might be possible to conduct a simpler experiment, using activated iron oxide catalyst, YAG laser, focusing lens, D2 gas, and a solid state particle detector inside a simple vacuum chamber with a window (a desiccator?).

If the Holmlid effect is real, then the scientific community has been sitting on a solution to the world's energy problems for more than 10 years. Holmlid's papers are widely read according to Google scholar and Researchgate, but very few people have acted on them.

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Progress in Constructing, Testing and Detecting Radiation from Lattice Energy Converter (LEC) Cells

[1]G. Andrew “Andy” Erickson, [2]Frank Gordon, [3]Harper Whitehouse
[1] Retired Senior Fellow, Los Alamos National Laboratory, USA
[2] Frank Gordon, INOVL, Inc., USA
[3]Harper Whitehouse, INOVL, Inc., USA
Email: andrewrcksn@gmail.com

Figure 1 - A successful LEC cell Pd-H Co-deposit Electrode (left)
Assembled LEC Cell system with Mica Window for Radiation Detection (right)

In November of 2020, successful replication of a LEC cell [1] was completed with an observed output voltage of over 350 millivolts into a 1 megaohm load in room air. Since that time, over a dozen different LEC cells of different construction have been built and evaluated with observed outputs up to 700 millivolts into a 200 kilohm load resistor. A variety of cells have been run at operating temperatures up to 200 degrees Celsius in vacuum, as well as room air, Argon and Hydrogen with pressures up to 30 PSIG. Many of these experiments were completed to quickly assess a wide parameter space as well as the reproducibility of LEC cells for a given set of conditions. More recently, experiments to assess whether ionizing radiation is being generated during the operation of these cells has been explored using a variety of detection methods including a Ludlam “pancake” detector, a doped NaI scintillator, an x-ray sensitive phosphor, a Moxtek Silicon pin diode and a 3 stage, thermoelectrically cooled cloud chamber [3].

This paper outlines the types of cells produced, the output results of the various cells, the ability to generate reproducible results for a given design, and the results of the radiation detection experiments that have been conducted to date.

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LENR Low Flux Neutron Spectroscopy

#L. Forsley,[1,2] T. Benyo,[1] B. Steinetz[1]

[1]NASA Glen Research Center, USA

[2] Global Energy Corporation, LLC, USA

Email: lawrence.p.forsley@nasa.gov

Although the most sought-after hot plasma fusion reactions use deuterium-tritium due to its higher fusion cross-section, the deuteron-deuteron fusion reaction is also used and is suspected in Low Energy Nuclear Reactions (LENR). Although LENR reactions are largely aneutronic, the D(*d,n*)^{3}He reaction produces a 2.45 MeV kinetic energy neutron. In the course of fusion experiments at NASA, ranging from bremsstrahlung photoneutron-initiated fusion [1] to Pd/D co-deposition [2], we've made use of liquid and solid neutron scintillator [3] spectrometers, bubble detectors and Solid State Nuclear Track Detectors (CR-39). Figure 1 shows the unfolded neutron energy spectrum from primary fusion and boosted fusion or stripped neutrons from photoneutron induced fusion. Despite an average deuteron energy of 64 keV, the peak unfolded neutron flux was only a few neutrons/minute. The major problem was the 10^{18} gamma ray/neutrons/second flux ratio.

This real-time, < 100 nsec temporal resolution, detector technology is being deployed with Pd/D co-deposition experiments along with CR-39.

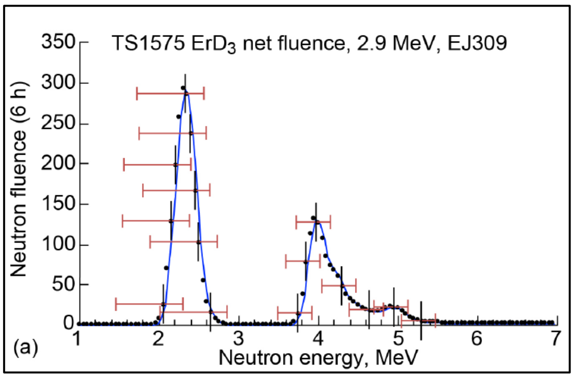

Figure 1 Photoneutron induced fusion

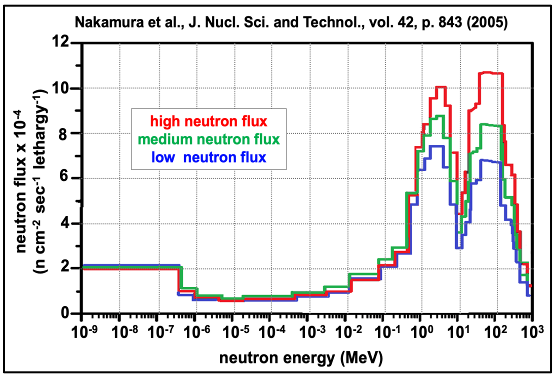

Figure 2 Cosmogenic Neutron Background Energy

However, there is a cosmogenic neutron background from cosmic ray collisions within the upper atmosphere [4] as show in Figure 2. The cosmogenic 1 MeV evaporation neutron energy peak overlaps with the 2.45 MeV DD fusion peak. More insidious are multiple LENR events occurring within the temporal resolution of the detector. This behavior was first noted by Menlove at LANL in the early 1990s conducting LENR neutron counting and later by Srinivasan at BARC. In both cases detector hardware or software vetoed multiple neutron occurrences as unwanted background or electromagnetic interference (EMI). The latter is worsened in plasma discharge experiments where EMI may trigger the neutron detector. To circumvent and filter out the stray triggers due to EMI, significant shielding is required. Additionally, multiple coincidence neutron scintillator detectors with an anti-veto "control detector" located several meters from the experiment can statistically deal with both multiple neutron events from the experiment and cosmogenic neutrons even at low count rates.

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Possible Explanation of LENR: Charge Cluster Micro Reactors

Luciano Ondir Freire[1], Dennis Pease[2,] Delvonei Alves de Andrade[1]
[1] IPEN, Brazil
[2] OptVac, USA
Email: luciano.ondir@gmail.com

Many diverse LENR experiments have yielded unexplained energy and reaction products that seem to defy thermodynamic laws and/or violate current nuclear theories. These extraordinary results have caused many researchers to summarily dismiss all LENR results as being erroneous without giving them due consideration. LENR experiments often yield transmutation products like those found in stellar nucleosynthesis regardless of their initial elemental composition. Typically, these nuclear reaction products are concentrated in or around small "hot spots" and these locations may contain several percent of new elements. Other characteristics of LENR reactions include the near absence of neutron and gamma rays; seldom observed creation of radioactive isotopes; acceleration of nuclear decay in radioactive isotopes; reaction rates correlating with neutron or other background radiation flux; and reactions triggered or influenced by LASER beams, temperature, current variations, and/or electromagnetic fields. Furthermore, the experimental techniques are very diverse and include electrolysis, plasma, gas loading, heating, cavitation, piezo mechanical excitation, ion beams, electron beams, gamma rays and even biological organisms. We believe that any successful explanation of LENR results need to consider the entire set of observed phenomena properties and not just to address a small subset of Ad Hoc chosen properties. Furthermore, any proper LENR theory should ideally account for unexplained phenomena in various exotic fields including strange radiation from dense plasma focus experiments, natural and artificial ball lightning, pyroelectric crystals creating D-D fusion, changes in nuclear reaction rates produced by orgone rooms (ORANUR experiment), and perhaps even provide an alternative explanation of dark matter. Researchers are always tempted to rely on current models and try to make small changes in, or extension of, those models. However, the diversity of LENR phenomenology makes the application of current theories very complex in the face of so many difficult questions such as: A) Why do so many LENR reactions appear to be concentrated in "hot spots" and how do these overcome the Coulomb barrier? B) Why are these "hot spots" only a few tens of micrometres in size and why do they not propagate and expand to fill the entire bulk of the material as occurs in nuclear chain reactions? C) Why does LENR cause so many types of simultaneous nuclear reactions and produce such diverse transmutations as compared to a typical nuclear reactor that fissions just a few isotopes? D) Why do LENR transmutations mostly yield stable, non-radioactive, and ground state isotopes? E) Why do radioactive isotopes seem to accelerate their rate of decay within LENR reactors? F) Why do LENR reactions not generate any observable gamma rays?

All of the above questions are very difficult to answer with current physics theories. This remains the case even if one assumes the existence of a new particle and/or postulates that known particles or nuclides may have unknown properties. Our "simple" explanation of LENR is that it occurs due to the existence of small clusters of negatively charged particles that can act as micro reactors. Such "charge clusters" have been reported by many authors including Ken Shoulders. Their observed properties include: A) Effective diameters of 0.1 to 100 micrometres; B) An intrinsic magnetic moment; C) Absorption of high energy (MeV) photons; D) Emission of low energy (<150 Kev) photons; E) Very long lifetimes (days) in certain solid materials such as Aluminium; F) The ability to propagate through solid materials; G) The ability to leave unique tracks on dielectrics; H) The ability to initiate nuclear reactions and transmutations.

We believe that the assumption of charge clusters acting as micro reactors can explain virtually all observed LENR phenomena and that this postulate is directly supported by observations of many authors in diverse fields including Wilhelm Reich, Takaaki Matsumoto, Robert Greenier, Ken Shoulders, Harold Puthoff, B. Rodionov, Irina Savvatimova, L. Urutskoev, Gennady Mesyats, Leopoldo Soto, S. Adamenko, and Paulo Correa. We therefore conclude, in accordance with the criteria of Occam's Razor, that the simplest and correct explanation of LENR's enigmatic data lies in the unique properties of charge clusters operating as micro reactors.

Using the online MFMP/Parkhomov LENR reaction calculator to review past data and drive future research

#Robert W. Greenyer [1], Phillip W. Power [2]
[1] MFMP, United Kingdom
[2] MFMP, New Zealand
Email: ICCF24@tir.co.uk

Upon request in early 2018, Dr. Alexander G. Parkhomov made available to the Martin Fleischmann Memorial Project (MFMP) a dataset he had calculated based on his February 2018 paper entitiled "Multeity of Nuclides Arising in the Process of Cold Nuclear Transmutations." [1]

An author of this paper proposed turning this data into an on-line free to use web application for the LENR community. This call was answered by two programmers.

The first application based on the initial dataset, was made by Denis LaMotte and can be found at http://fusfis.org.

A second application was developed by the authors of this paper which has more flexibility of query and incorporates the potential role of technologically synthesised Cold Neutrinos (equivalent to cosmogenic relic neutrinos) as calculated by Dr. Parkhomov in his November 2018 follow up paper entitiled "Multeity of Nuclides Arising in the Process of Cold Nuclear Transmutations Involving Electrons." [2]. This tool can be found at https://www.nanosoft.co.nz

This second free online tool, which has been developed and tested extensively [3] is now mature. It allows the investigation of three idealised exothermic nuclear reactions: Fission, Fusion and 2-2 reactions in LENR. The sub programs calculate the net Binding Energy differences between the output(s) and the input(s). By considering that the most desirable outcomes would be those that woud fit the resulting nuclei into the 'smallest box', we have found that the most energetically favourable reactions tend to be those that have been observed in past experiments and, by inference, can be predicted to occur in future experiments. Not yet factored in is the probability or cross sections of these reactions but here, it should be noted that cross sectional measurements to date are mostly confined to isolated measurements in a vacuum rather than in the context of condensed matter.

Examples of the applications output against past obeservations will be presented alongside dicussion of how it is being used to inform and direct futher research in the field.

Fusion: https://www.nanosoft.co.nz/Fusion.php
E1 in ('C') and E2 in ('O') order by MeV

id	neutrino	id_sub	E1	A1	nBorF1	Z1	aBorF1	E2	A2	nBorF2	Z2	aBorF2	E	A	nBorF	Z	aBorF	MeV
2407	none	833	C	12	b	6	b	O	16	b	8	b	Si	28	b	14	b	16.755700
2503	none	834	C	13	f	6	f	O	16	b	8	b	Si	29	f	14	f	20.286100
2408	none	835	C	12	b	6	b	O	17	f	8	f	Si	29	f	14	f	21.091800
2409	none	837	C	12	b	6	b	O	18	b	8	b	Si	30	b	14	b	23.659000
2504	none	836	C	13	f	6	f	O	17	f	8	f	Si	30	b	14	b	26.759000

E1 in ('D') and E2 in ('Pd') order by MeV desc

id	neutrino	id_sub	E1	A1	nBorF1	Z1	aBorF1	E2	A2	nBorF2	Z2	aBorF2	E	A	nBorF	Z	aBorF	MeV
444	none	867	D	2	b	1	f	Pd	105	f	46	f	Ag	107	f	47	b	12.828500

Fission: https://www.nanosoft.co.nz/Fission.php
E = 'W' order by MeV desc

id	neutrino	E	A	nBorF	Z	aBorF	E1	A1	nBorF1	Z1	aBorF1	E2	A2	nBorF2	Z2	aBorF2	MeV
1449	none	W	180	b	74	b	Ti	50	b	22	b	Te	130	b	52	b	88.948400
1475	none	W	184	b	74	b	Ca	48	b	20	b	Xe	136	b	54	b	85.144100
1462	none	W	182	b	74	b	Ca	48	b	20	b	Xe	134	b	54	b	84.308600
1448	none	W	180	b	74	b	Ca	48	b	20	b	Xe	132	b	54	b	84.258300
1447	none	W	180	b	74	b	Ca	46	b	20	b	Xe	134	b	54	b	81.871800
1461	none	W	182	b	74	b	Ca	46	b	20	b	Xe	136	b	54	b	81.375300
1446	none	W	180	b	74	b	Ca	44	b	20	b	Xe	136	b	54	b	78.496100
1444	none	W	180	b	74	b	Si	30	b	14	b	Nd	150	b	60	b	48.911800
1443	none	W	180	b	74	b	Mg	26	b	12	b	Sm	154	b	62	b	39.475800

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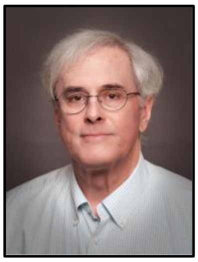
LENR on Surfaces or in Plasmas



#Joseph Peter Guokas
Independent Researcher, United States

Email: joeguokas@gmail.com

Many reports of hydrogen or deuterium in certain metals along with some energy input, yield unexplained heat, and in some cases transmutations. Two major difficulties are:
1. Often the same inputs to the system do not result in the same output.
2. The interiors of the metal samples where the events occur are difficult to observe in real time.

Enough of these excess heat events occur to make further study worthwhile, but it could be very helpful to find a way to trigger the anomalous conditions in a configuration where the environments at the anomalies are controlled (or at least closely measured) and the sites of the anomalies are open to real-time, direct observation.

Here we present findings of mathematical models and computational chemistry, in the search for conditions that could form on the surface of metal, or even without metal in low energy and relatively low-density plasmas. Even if these reactions are not as strong as those inside metals, we may learn more about LENR principles by studying reactions that are not inside metals, by controlling outside the metal and observing outside the metal.

Matrix elements for HD/^{3}He and D_2/^{4}He transitions

#P. L. Hagelstein
Massachusetts Institute of technology, US
Email: plh@mit.edu

The D_2/^{4}He transition has been proposed as the first (half) step in models for excess heat in the Fleischmann-Pons experiment, with the analogous HD/^{3}He transition playing the same role for excess heat in experiments with hydrogen instead of deuterium. These transitions have also been proposed to play a role for excitation transfer in which the associated large quantum is transferred to another nucleus resulting in disintegration, a mechanism proposed to account for low-level nuclear emission claimed in some experiments.

We have developed simple models to evaluate matrix elements for these transitions mediated by phonon, spin-wave, or other oscillator exchange.

Off-resonant energy shifts of the lowest two states of Fe-57

P. L. Hagelstein
Massachusetts Institute of Technology, US
Email: plh@mit.edu

Excitation transfer under normal conditions suffers from destructive interference effects, resulting in indirect coupling matrix elements that are much smaller than the contributions from individual paths in perturbation theory. We have long been interested in mechanisms that can spoil this destructive interference. In 2002 we noticed that loss mechanisms asymmetric in the energy off of resonance would dramatically accelerate multi-quanta down-conversion, which proceeds through many sequential excitation transfer steps. More recently, we found that off-resonant energy level shifts were more likely responsible for excited state nuclear excitation transfer in experiments with Co-57 and Fe-57.

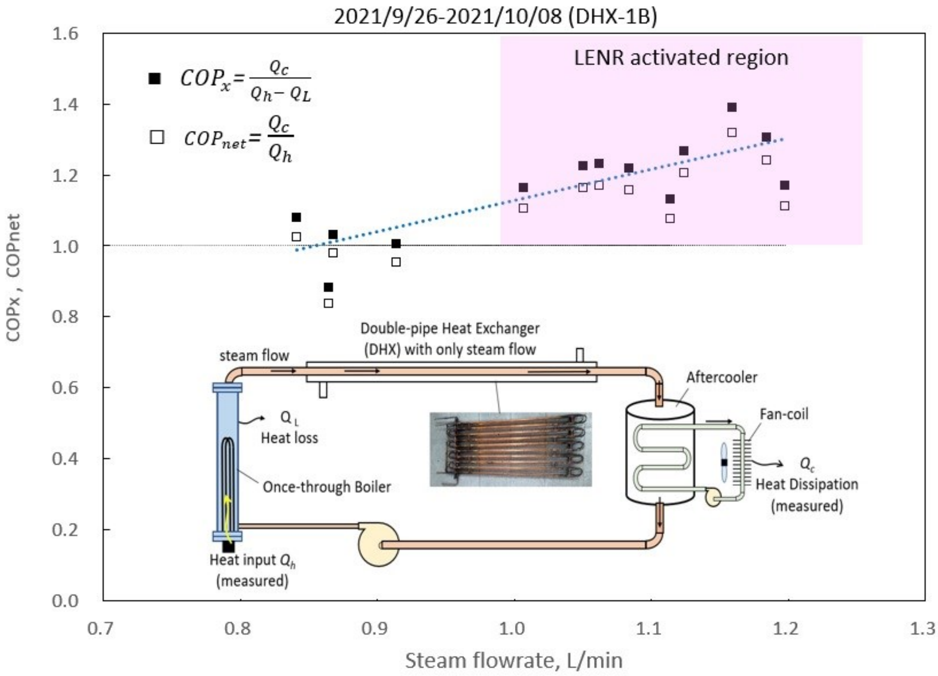
We have recently carried out shell model calculations to estimate the off-resonant energy shift of the ground state and first excited state (at 14.4 keV) of Fe-57. Contributions to the off-resonant energy shift come from differences in the LO (lowest-order) central and tensor contribution from chiral effective perturbation theory nucleon-nucleon potentials. The model and associated results will be described.

Generation of Excess Energy from Two-phase Flow

#Bin-Juine Huang, Yu-Hsiang Pan, Tsung-Yu Lee, Po-Hsien Wu,
Jong-Fu Yeh, Ming-Li Tso, Ying-Hung Liu, I-Fee Chen
Department of Mechanical Engineering,
National Taiwan University, Taipei, Taiwan
Email: bjhuang38@gmail.com

In ICCF-22 and ICCF-23, we presented the results of excess energy obtained from a vapor compression machine (VCS) and a double-pipe heat exchanger (DHX) [1,2]. In VCS, the hot refrigerant vapor from the compressor is used to heat the water flowing through a tiny passage of a triple-pipe heat exchanger. In DHX, water flows through a tiny passage in double-pipe heat exchanger (DHX) and the heat source is hot steam from a boiler. This may cause a violent water cavitation and even LENR. The test results show that the maximum COP_x reaches 2.39 in VCX machine and 2.55 in DHX machine [3]. We observed some peculiar phenomena. Abnormally high pressure (>740 bar in VCS and >225 bar in DHX) occurred and causes copper pipe buckling and crack. Nuclear transmutation was observed. The chemical element of the ruptured copper pipe increases by 3 to 4 folds in C, 10 folds in O, and 1.4 to 4.4 folds in Fe. We experimentally confirm that excess energy or LENR can be induced by heat transfer process involving cavitation in two-phase heat-exchange systems which was reproduceable and controllable.

We continued the experiment using the same DHX machine [2,3] but with only steam flow through the inner pipe. That is, no heat exchange with water stream in DHX. We used a once-through boiler to supply the steam flow (mixed with water). The test results shows that COP_x varies with steam flowrate and the maximum COP_x is 1.40 for heat input Q_h around 6 kW. We can control the LENR at certain conditions. This indicates that the excess energy can be produced by a two-phase flow through a passage.



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Single Physics of Condensed and None Condensed Matter I: Fundamental Laws and Constants

Mikhail Ivanov [1, 2]
[1] Central Institute of Aviation Motors, Moscow, Russia
[2] Moscow University of Power Energy, Russia
Email: mikhivan@yandex.ru

With a certain item of conditionality, the generalized concept of "condensed matter" should include any matter consisting of atoms and molecules, additionally including in this concept an ordinary gaseous medium and plasma (in addition to Bose's and Fermi's condensates). Then any medium that fills the free space between atoms and molecules (naturally, if it exists) will be attributed to the concept of "non-condensed" matter. Examples here are photonic gas, dark matter, any ethereal medium, as well as a "physical" vacuum. In the presented work, the unified nature of the condensed and non-condensed medium defined in this way is considered. A closed system of universal conservation laws of mass, momentum and energy is written out [1-3] (valid for condensed and non-condensed media). The analysis of the minimum number of basic fundamental constants necessary for a closed formulation of the problem is carried out and their justification is given. At the same time, the main emphasis is on compliance with modern experimental data.

It should be specially emphasized that many new experimental achievements of the XXI century do not fit into the standardized theoretical models of the XX century physics. Here, first of all, one should be noted the reliable registration of the matter motion at speeds significantly exceeding the speed of light (in cosmic jets, in the spread of distant galaxies, during the registration of gamma-ray bursts and neutrinos, etc.). An equally important experimental result should also be called the registered movement of the Earth and the Solar System relative to cosmic microwave radiation ("new ether"). In connection with the above, it is quite reasonable to return to the consideration of astrophysics and cosmology outside the framework of the today standardized theoretical models. We also note the fundamental contradictions in quantum theories at the level of elementary particles (the "zoo of particles" recorded in experiments at the LHC, "seas of quarks" and the pressure inside the proton, other known violations of standard physics models).

The main purpose of this work is to demonstrate the possibility of constructing consistent physics of the field and any matter (in particular, LENR physics) within the framework of the classical methodology for the continuum and its conservation laws. In particular, when considering the question of classical gravity (in a potential formulation), the temperature value will naturally enter into the unified quasi-linear Hooke-Newton-Coulomb equation in the Poisson-Boltzmann form [4]. Dimension analysis is used to determine the characteristic mass of a medium particle, the gravitational frequency (similar to the known plasma frequency) and the corresponding gravitational time period. Based on these values, a model of the pulsating Universe is proposed. Analytical solutions for mass capture by black holes and for cosmic jets propagating from the centres of quasars and active galaxies will be presented. Also one of the possible LENR simulations is considered [5]. At the same time, it is necessary to note the extensive experimental verification of the main theoretical methodology.

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Anomalous Temperature Increase of Boron Carbide Block near An Electrochemical Cell: A New Experimental Approach to LENR

#Sungho Jo
Independent Researcher, USA
Email: sungho_jo@yahoo.com

One of characteristics of Low Energy Nuclear Reaction (LENR) is relatively low input energy to drive nuclear reaction. In efforts to explain this characteristic, some researchers (e.g., [1], [2]) suggested that, under special circumstance, neutrons are first generated from protons and electrons with low input energy, and then the generated neutrons induce subsequent nuclear reaction, for example, fusion in [1], decay in [2].

If thermal neutron is actually generated with low input energy, "Thermal neutron absorption by nucleus → Nuclear reaction (fission, transmutation/decay) → Energy release as heat" process is expected to follow, according to the textbook nuclear physics. This new LENR scenario can be validated if anomalous temperature increase is observed when a material with large thermal neutron absorption cross section is located close to where thermal neutrons are believed to be generated with low input energy.

An experiment is devised to validate this LENR scenario, where 1) an electrochemical cell is used to generate thermal neutrons from protons and electrons; 2) boron carbide block is located in the vicinity of cathode to absorb thermal neutrons. Boron carbide is selected because i) 20 % of boron atoms in boron carbide is ^{10}B; ii) thermal neutron absorption by ^{10}B, which produces He and Li and releases energy of 2.79 MeV (partly in gamma ray), has large cross section [3]. The electrochemical cell in this work uses 1) graphite rod as anode, 2) copper or "material S" as cathode, along with 3) light water electrolyte solution ("solution A" or "solution B"). "Material S" and electrolyte solutions do not contain materials used in the original Fleischmann-Pons experiment [4] or its many variants. Thermocouples are used to measure temperatures of cathode (T1) and boron carbide block (T2) during electrolysis with DC voltage.

Since electric power is dissipated in the electrolysis process, heat is produced in the electrochemical cell, which results in the increase of T1 (ΔT1). The produced heat is transferred from cathode to boron carbide block, resulting in the increase of T2 (ΔT2) during electrolysis experiments with (cathode/solution) combinations of (Cu/solution B) and ("material S"/solution A). However, for the ("material S"/solution B) combination, an anomalous temperature increase of T2 (ΔT2′) was repeatedly observed, where **ΔT2′ ~ 1.37 X ΔT2** on average. This result indicates that excess heat is indeed produced in boron carbide block, and therefore, validates "Thermal neutron generation → Subsequent absorption by ^{10}B" scenario. Details of the experimental results will be presented.

In addition, "head-on collision of electron with proton" model will also be presented as a possible mechanism of thermal neutron generation.

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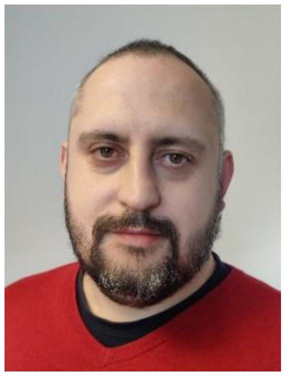
Latest upgrade of University of Szczecin accelerator system for fusion reactions below 1keV



#M. Kaczmarski[1], K. Czerski[1], R. Dubey[1], A. Kowalska[2] , N. Targosz-Sleczka[1] , M. Valat[1],
[1] Institute of Physics, University of Szczecin, Wielkopolska 15, 70-451 Szczecin, Poland,
[2]Institute of Mathematics, Physics and Chemistry, Maritime University of Szczecin,
70-500 Szczecin, Poland
#Email: mateusz.kaczmarski@usz.edu.pl

Investigation of nuclear reactions at energies below 1 keV is of highest interest for cold fusion research. Technical difficulties causes, however, problems hard to overcome. Therefore, new deceleration lenses at the accelerator system of the University of Szczecin [1] have been installed in recent months. The deceleration system allows to decrease initial energy of ions emitted by the electron cyclotron resonance ion source to energies below 1 keV, keeping the beam current up to 1 mA. Additionally, the maximum acceleration voltage is increased to the value 26 kV. This upgrade is committed to acceleration of light ions where solid plates are used as targets with the control of target temperatures in the range between LN and 1000°C. Furthermore, the Auger electron spectroscopy (AES) enables to detect atomic monolayers of the surface contamination.

Combining the ultra-high vacuum (UHV) target chamber with the high current accelerator system of the energy resolution and long term stability of only few eV will allow reliable method for measurement of the electron screening energy and absolute cross sections of fusion reactions at energies never measured before.

The study is part of the CleanHME project. This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 951974.

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Synthesis of silicon in the interaction of aluminum with a quasi-neutron and estimation of the contribution of the aluminum hydride complex

#Mikhail Kashchenko [1,2], Maxim Kovalenko [1], Vladimir Pechorsky [2], Anatoly Kupryazhkin [1], Nadezhda Kashchenko [1]

[1] Ural federal university, Russia

[2] Ural state forest engineering university, Russia

Email: mpk46@mail.ru

Among the nuclear fusion reactions of new elements, the simplest reaction refers to the capture of a proton p by the nucleus of the original element ${}_ZX^A$ with the formation of the ${}_{Z+1}Y^{A+1}$ nucleus (Z and A are the charge and mass number of the element X). In the case of cold fusion, the occurrence of such a reaction is associated with the existence of quasi-neutron ($p + e$) states [1, 2] in which the proton is "escorted" by the electron e:

$$ {}_ZX^A + (p + e) \rightarrow {}_{Z+1}Y^{A+1} + e. \qquad (1)$$

For example, in [3], the synthesis of zinc from copper was established. According to [2], with several stable isotopes of the initial element, it can be expected that the ratio of isotopes of the daughter element Y formed in reactions (1) will be close to the ratio of the proportions of the corresponding parent isotopes of X in nature. It is important that the ratios of the proportions of synthesized isotopes in most cases should differ significantly from natural ratios, which would certainly confirm their artificial origin. The data of preliminary mass spectrometric measurements for the synthesis of zinc from copper, gallium from zinc, and rhenium from tungsten are consistent with this conclusion. However, for relatively heavy elements, the masses of daughter atoms with ${}_{Z+1}Y^{A+1}$ nuclei are difficult to distinguish from the masses of hydride complexes of parent atoms with ${}_ZX^A$ nuclei and hydrogen atoms H formed in the course of mass spectrometric measurements. In this regard, the problem of estimating the contributions of daughter atoms and hydride complexes is topical.

The solution of this problem was carried out for the case of silicon synthesis from aluminum. In an air environment with water vapor, an electric arc was ignited between an aluminum anode and a tungsten cathode. Aluminum has one stable isotope ${}_{13}Al^{27}$; therefore, the synthesis of only one of the three stable silicon isotopes ${}_{14}Si^{28}$ was expected, which was observed in the mass spectrum of the powder formed on the anode surface (peak at ≈ 27.977 a.m.u.). The AlH complex corresponds to a peak at ≈ 27.989 a.m.u. This peak has a height approximately 2.5 times less than the height of the peak for the mass distribution of silicon atoms. Thus, the relatively low intensity for the mass distribution of the AlH complex suggests that it is the isotope ratios of the synthesized daughter nuclei that make the main contributions to the observed isotope mass ratios in the cases of parent atoms having several stable isotopes.

The results obtained indirectly testify in favor of the concept of quasi-neutron states in the implementation of cold fusion of nuclei in reactions (1).

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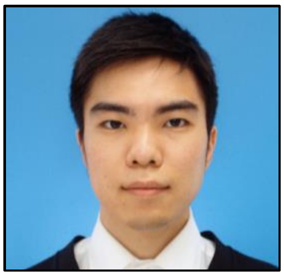
Estimation of the heat generation of the metal composite powder absorbing the pulsed flow of hydrogen gas



#Tomotaka Kobayashi [1], Ken Naitoh [1], Daiki Okada [1]
[1] Waseda University, Japan
Email: winningshot1996@asagi.waseda.jp

Anomalous heat generations in exposure of nickel or palladium powder to hydrogen or deuterium gas were reported [1-2]. Especially, we focused on the anomalous heat generations in hydrogen (or deuterium) gas absorption by metal composite powder reported in previous research [2-3].

In our previous report, fundamental experiments of anomalous heat generation in hydrogen gas absorption were conducted. In the experiments, about 10 K of temperature rise was observed in the absorption of 0.5 MPa hydrogen gas by Pd-Ni-Zr composite powder at 244 ℃. [4]

In this research, we added a solenoid valve to our reaction system with small chamber (Fig. 1) and conducted hydrogen gas absorption experiment with pulsed flow generated by solenoid valve, up to 300 ℃ and 0.9 MPa. As a result, over 30 K of temperature rise was observed.

We also estimated the calorific value generated in the experiments. Obtained result implies that pulsed flow of hydrogen gas increases the amount of heat generation.

a) overall view b) reaction chamber
Fig. 1. Reaction system with small chamber

We would like to thank Technova Inc. for helpful discussion and providing the sample.

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Poster proposal: Unified Field Theory and Occam's Razor

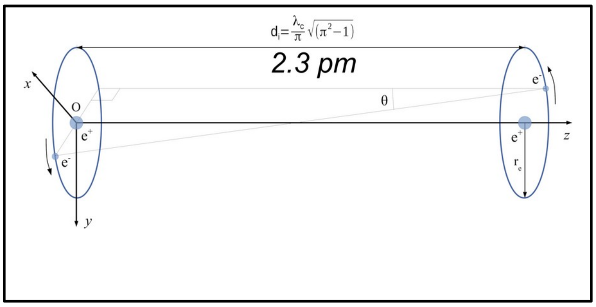
#Andras Kovacs[1], Giorgio Vassallo[2], Paul O'Hara[3], Francesco Celani[4], Antonino O. Di Tommaso[2]
[1] BroadBit Energy Technologies, Slovakia
[2] University of Palermo, Italy
[3] Sophia University, Italy
[4] INFN, Italy
Email: andras.kovacs@broadbit.com

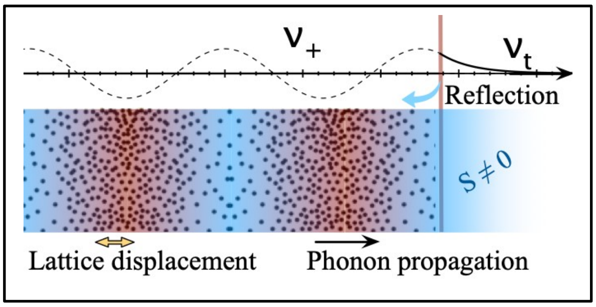
Unified Field Theory was an expression first used by Einstein in his attempt to unify general relativity with electromagnetism. Our book titled Unified Field Theory and Occam's Razor [1] attempts to provide real answers to foundational questions related to this unification and should be of high interest to innovative scientists. In the hope of a fruitful dialogue with all who are interested in this subject, our online poster presents some key ideas from the book, which are relevant to low-energy nuclear reactions:

- **The Dirac equation as a proper field equation**. Our results complete Dirac's program of developing a renormalization-free understanding of his equations, and making sense of the imaginary components in the "spinor field". We show that the Dirac spinor field can be factorized into a real-valued scalar component, which is the particle's probability density, and a real-valued vectorial component, which is the electromagnetic vector potential experienced by its charge density. This improved understanding of the Dirac equation is a proper foundation for theory development, and its factorization shows that nuclear isospins have electromagnetic origin.

- **Compton-scale Electron-Proton or Electron-Deuteron composites**. We explain pm-scale electron-nucleus constellations shown in the bottom left figure. Our theory results explain electron-mediated nuclear fusions, including: the 2.3 pm inter-nuclear distance in the "Ultra-Dense Deuterium" composite (L. Holmlid's and S. Olafsson's groups), electron-mediated fusions (M. Lipoglavsek's group) where the mediating electron sometimes carried away the entire fusion energy, the observation >7 MeV particle energy in D-D fusions (P.A. Mosier-Boss' group).

- **Phonon-induced nuclear fission at phonon-reflecting surfaces**. We explain phonon-mediated nuclear fissions to be induced by the electromagnetic scalar field arising at phonon-reflecting surfaces, as illustrated in the bottom right figure. Our theory results explain surface transmutations, including: fissions on fracture surfaces (A. Carpinteri's group), fissions on sonicated metal surfaces (F. Cardone's group), fissions on nickel surfaces (Y. Iwamura's group).





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Correlating transmutations to excess ionizing radiation in light water electrolysis under steady and periodic high potentials

[#]Ankit Kumar,[1]Monu Kumawat,[1] Shyam Sunder Lakesar,[1]Harishyam Kumar[1],K Ramkumar[1] ,Raj Ganesh Pala,[2] Pankaj Jain,[3]K P Rajeev.[1]

Department of Physics, Indian Institute of Technology Kanpur,India[1]

Department of Space Science and Astronomy, Indian Institute of Technology Kanpur,India[3]

Department of Chemical engineering, Indian Institute of Technology Kanpur,India[2]

ankt@iitk.ac.in[#] ,rpala@iitk.ac.in

We report measurement of ionizing radiation generated from the electrolytic cell and elemental transmutations on Kanthal cathode ($Fe_{0.74}Cr_{0.21}Al_{0.05}$) from a highly biased (~40 V_{rms} from a half-wave or bridge rectifier) two-electrode system in 1 M K_2CO_3 electrolyte deionized water electrolysis against a pure graphite anode.

Building upon our previous experiments on nuclear transmutation via Kanthal® samples in light water electrolysis[1], we observed ionizing radiation of the order of MeV (primary or secondary) could be produced during transmutation. Multiple reports have been published describing radiation emission from metal-hydrogen electrolytic and gas discharge LENR experiments, [2,3,4] However, the sporadic nature of radiation emission in experiments makes it hard to confirm that LENR is accompanied by radiation.

Correlating radiation to transmutation is also indispensable for formulating a viable LENR theory. First, concomitant radiation will unambiguously indicate nuclear activity. In case radiation is observed, perhaps the chances of finding a mechanism within traditional nuclear physics may be higher. If radiation is not commensurate with transmutation, then some new mechanism for transmutation outside classical nuclear physics may have to be explored.

All the above-mentioned reasons led us to design a special experimental setup to find a correlation between radiation and transmutation. To measure different kinds of radiation, we employ three detectors: NaI (Tl) solid-state Gamma photon detector, Geiger tube Ionizing radiation and particle detector to measure any kind of ionizing radiation produced. In order to exclude the high atmospheric gamma shower, we perform all the electrolysis and radiation measurement inside a lead (Pb) enclosure. We use Energy-dispersive X-ray spectroscopy (EDS) for the preliminary characterization of transmutations at the cathodes. Inductively coupled plasma-mass-spectrometry (ICPMS) is used to determine the ppb level composition of the electrolyte before and after the electrolysis.

Besides ionizing detection, we are also standardizing simultaneous neutron detection (if any) and hydride formed on the cathode, all of which have been indicators of LENR.

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Development and testing of a high-precision, 256 channels, data acquisition system based on open-source hardware and software for LENR experiments

#Emanuele Marano[1]
[1] ISCMNS_L1: Intern. Soc. of Cond. Matter Nucl. Science, Via Cavour 26, 03013 Ferentino (FR), Italy
Email: 310830@edu.unito.it

Can an undergraduated student with a limited amount of resources perform high precision electrical and thermal measurements on LENR experiments?

In recent years the access to electronic devices containing easily programmable microprocessors able to read electrical data and/or pilot actuators (e.g Arduino[1], Theremino[2]) has become common worldwide. Often such devices are very cheap, but they offer a limited amount of channels and/or a limited precision (usually 8 to 12 bits) or simply cannot be adapted for specific or complex tasks without a huge technical knowledge or expense of time.

In the present work it is show how a data acquisition system (DAQ) based on Theremino open source hardware and software [2] was built and adapted on a multiple cell electrolysis system. A custom-made interface board was designed and printed using an online service available worldwide[3] in order to expand to 256 or more the number of available channels, each with a theoretical resolution of 24bit. They can be used to read voltage or temperature data from Pt1000 sensors.
Following recent developments by the Theremino team [2] a software able to control all the hardware, read and monitor live data, compute physical quantities and logging them to file was easily written, allowing customizable experiments to be performed.

Main features and performances of the DAQ system will be described, as well as the way to calibrate it and its application to LENR electrolysis experiments.

[1] https://www.arduino.cc/
[2] https://www.theremino.com/
[3] https://jlcpcb.com/

Design, construction and characterization of a Seebeck calorimeter for electrolysis electromigration experiments

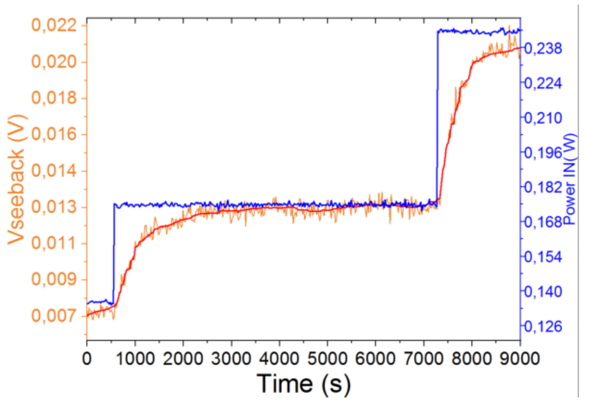
#Emanuele Marano[1]

[1] ISCMNS_L1: Intern. Soc. of Cond. Matter Nucl. Science, Via Cavour 26, 03013 Ferentino (FR), Italy

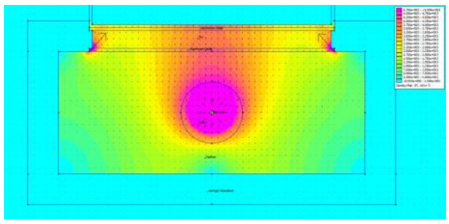
Email: 310830@edu.unito.it

A Seebeck calorimeter was designed with the following features: small reacting volume (~ 4 cm^3), good sensitivity (~130mV/W), relatively fast time constant (~10 min), cost effectiveness and being suitable for electrolysis experiments with electromigration on one electrode[1].

Furthermore, the calorimeter was also designed in order to be built from commercially and easily available materials on the online market. Its thermal behaviour was simulated by mean of 2D finite elements analysis and its design was optimized following such study.
Performances of the actual device were tested and results were found to be in agreement with simulation. The device can thus be used in order to first replicate and verify some results reported in LENR literature[1].



Time response (orange) of the real device after changes in input power (blue)



Simulated heat flow through a cross section of the calorimeter. (pink = high heat flow, green/azure = low heat flow)

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Confinement Induced Electron Capture

Charles H. Martin [1] and Robert Godes [2]

[1] Calculation Consulting, USA

[2] Brillouin Energy, USA

Email: charles (at) calculationconsulting.com

We describe a Gedankenexperiment in which a bare proton can capture an electron due solely to confinement. We first briefly review orbital electron capture and related processes. We then describe the Fermi VA theory and how it can be applied to compute the cross section and rate using the full relativistic Kinematics. We set the problem up as a (proton, electron) pair confined in classical box of size L, and compute the cross section using the full Weak Interaction Hamiltonian. We provide numerical solutions for electron capture rate, and compare the power output relative to that of a neutron being captured in the post-reaction. We find that the capture is most likely for L=0.004-0.009 Angstroms, well beyond the radius of the proton and the reduced Compton wavelength of the electron. We estimate the theoretical minimal power output for such a process, seeing that is feasible at large box lengths. Finally, we discuss proposals for future work and possible applications.

New Applications of the Lower Bound Method For Isoperibolic Calorimetry

Melvin H. Miles
College of Science and Technology, Dixie State University
St. George, Utah 84770 (USA)
email: mhmiles1937@gmail.com

The lower bound calorimetric method introduced by Fleischmann and Pons in 1993 [1] has been mostly ignored despite some very useful applications for the calorimetry of the Pd/D_2O system. For example, over the first few minutes of electrolysis, this method provides valuable information about the deuterium loading process for the palladium cathode and may also detect any early excess power production. This method can also be useful for the detection of any significant changes in the calorimetry or if any unusual chemical reactions are present. Although this method was first reported for the Fleischmann-Pons Dewar calorimetry, it can also be readily applied to calorimetry where the heat transfer is by conduction and $T - T_b = \Delta T$ is used instead of $T^4 - T_b^4$ [2].

For isoperibolic calorimetry with heat transfer by conduction, the basic calorimetry equation is

$$C_pMdT/dt = (E - E_H)I - k(T - T_b) + P_X + P_g + P_W \quad (1)$$

where k is the true conduction cell constant, P_X is any excess power and P_g + Pw represent power loses due to the escape of D_2, O_2, and D_2O gases including the work done by these gases [2].

My modification of the lower bound method was to assume that $P'_X = P_X + P_g + P_W = 0$ rather than just the assumption that $P_X = 0$. However, the sum of $P_g + P_W$ is generally smaller in magnitude than about -l0 mW except for high cell temperatures (T > 60° C) and high cell currents (I > 500 mA). Because P_g and P_W are always negative in sign, P_X will always be somewhat larger than P'_X.

For the assumption of $P'_X = 0$, the lower bound cell constant (k') is given simply by

$$k' = [(E - E_H)I - C_pMdT/dt] / (T - T_b) \quad (2)$$

and the actual experimental P'_X value is given readily by

$$P'_X = (k - k')(T - T_b) \quad (3)$$

where $P'_X = P_X + P_g + P_W$. The value for k' should always be equal to or less than the actual cell constant (k) unless there is some unusual change in the calorimetric system.

A useful rearrangement for Eq. 3 is

$$k' = k - P'_X / (T - T_b) \quad (4)$$

Any early P'_X effects when $T - T_b$ is small can result in initial negative values for k'. The usual exothermic loading of deuterium into palladium can result in such initial negative k' values [1]. In contrast, any experiment with no excess heat effects will show that k' is always approximately equal to k.

My applications of this lower bound method to the $Pd\text{-}0.5B/D_2O$ systems have shown that P'_X = 118 mW very early after only 8.0 minutes of electrolysis. In addition, negative k' values existed for the first 10 minutes of this electrolysis. At the time when k' = 0, then Eq. 4 shows that $P'_X = k(T - T_b)$. My application of this lower bound method to a co-deposition experiment where there was a foaming problem readily identified the measurements where the k' values were larger than k due to such foaming.

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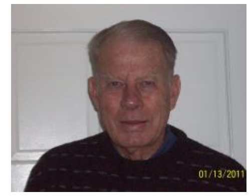
The First Cold Fusion Experiments Reporting the Correlation Between Excess Heat and Helium-4 Production



Melvin H. Miles
College of Science and Technology, Dixie State University
St. George, Utah 84770 (USA)
Email: mhmiles1937@gmail.com

These important experiments for the Pd-D_2O electrochemical system were completed at the China Lake Navy Laboratory in California late in 1990 and first published early in 1991 [1]. The helium measurements were conducted at the University of Texas during this same time period [1]. By 1991, most scientists considered that reports of cold fusion were incorrect, therefore our heat and helium-4 (He-4) correlations were simply dismissed as atmospheric helium contaminations. There are now more than 15 cold fusion groups that have identified He-4 production in Pd-D_2O experiments that produced excess heat [2].

Prior to our cold fusion experiments with He-4 measurements, various methods involving glass flasks were investigated for the collection of gas samples at China Lake and then shipping them to Texas for helium-3 and helium-4 analyses. The gas samples from a large boil-off liquid nitrogen tank were found to be the only ones tested where no helium could be detected at the University of Texas. This proved that our methods were sufficient to avoid any detectable amounts of atmospheric He-4 from diffusing into our gas samples in these experiments.

It is now known that the amounts of He-4 in ppb (parts per billion) for such electrochemical experiments is given by

$$\text{He-4 (ppb)} = 55.91\ (P_X/I) \qquad (1)$$

where P_X is the excess power in Watts and I is the cell current in Amps [2]. From this equation, the He-4 detection limit is estimated to be about 5 ppb for these 1990 University of Texas measurements. Furthermore, our reported small, medium, and large He-4 peaks were likely near 10 ppb, 20 ppb, and 40 ppb respectively. Using Eq. 1, our largest excess power measurement of 0.52 W at a cell current of I = 0.660 A yields 44 ppb for He-4. Our ten excess power and He-4 measurements were in the correct order except for two flasks that may have simply become confused [2]. There was no experimental evidence for He-3 production.

Our later experiments determined the actual rates for atmospheric He-4 diffusion into these glass flasks [2]. For three flasks filled with $D_2 + O_2$, this mean diffusion rate for atmospheric He-4 was 0.18 ± 0.02 ppb/day [2]. Therefore, it would have taken 28 days for atmospheric He-4 diffusion to reach our 5 ppb detection limit for He-4. For most of our gas samples, these He-4 measurements were completed in less than a 25-Day time interval. Furthermore, a following set of control experiments using a H_2O electrolyte did not show any He-4 production. Critics of cold fusion in 1990 were often stating that if these electrochemical experiments actually involved nuclear fusion, then there must be some measurable fusion product. Our 1990 experiments were the first to report that this fusion product is He-4 for the Pd-D_2O system.

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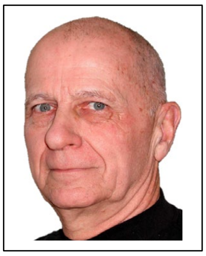
ElectroMigration and LENR



David J. Nagel
George Washington University, U.S.A.
Email: nagel@gwu.edu

Two conditions have to be satisfied for measurable production of LENR. First, there must be adequate concentrations of the reactants in some regions of the materials on or in which LENR occur. Low concentrations lead to low reaction rates, which might not be measurable using calorimeters. Second, there must be motions of the reactants. Reactions require interactions, and interactions require motions due to fluxes or vibrations. Electromigration has been shown to be effective in causing LENR because it leads to both enhanced concentrations and more frequent interactions. This paper reviews published electrochemical electromigration LENR experiments, and suggests some future experiments.

Electromigration is the movement of ions within conductors, such as protons or deuterons inside of palladium or other materials, caused by electrons moving down the field gradient due to an applied voltage. Momentum, transferred from electrons to the hydrogen nuclei by collisions of the voltage-driven electrons with the dissolved interstitial protons or deuterons, causes the motion. The effect was discovered in 1861, and has a long history independent of LENR [1]. Electromigration received much attention during the last century due to the fact that integrated circuits on chips can fail because their high areal current densities cause electromigration of ions in the conductors that connect transistors [2].

Several LENR researchers have used thin cathodes in electrochemical experiments, and applied voltages along their length (in addition to the electrochemical voltage between the cathode and anode) to cause electromigration. The first "cold fusion" experiment using electromigration was reported in 1991 [3]. Celani and his colleagues have performed many significant LENR experiments with electromigration from the mid-1990s [4] to this conference [5]. The most remarkable electromigration result was reported by Preparata and his colleagues in 1996 at ICCF-6 [6]. The cathode was a wire of Pd 50 μm in diameter and 250 cm long. In one run, the experiment produced an output power of over 170 W when the input power was 87 W. Normalizing the excess power to the volume of the cathode gave reported power densities in the range of 50 to 100 kW/cm^3, values higher than in a fission reactor fuel rod.

It seems clear that experiments, such as the ones reported by Preparata, ought to be repeated with a wide variety of palladium materials from various sources with both protons and deuterons. Calorimetry could be used, as was done the LENR electromigration experiments noted above. *In situ* x-ray diffraction measurements are possible, and would be instructive. In addition, the thin wires used as cathodes in electromigration experiments could be segmented and analyzed post-run for transmutation products by using sensitive analytical techniques. Appearance of transmutation products near the ends of the wires, where protons or deuterons piled up due to electromigration, would be powerful evidence of LENR and the value of electromigration. Electromigration with hot gas and plasma loading, rather than electrochemical loading, also seem possible, and should be considered.

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Heat Evolution in Hydrogen/Deuterium Desorption with Pd Foil Coated with Metal Membrane

#Shinya Narita, Nagayuki Yanagidate, Hiroki Matsuhashi, Masanari Endo
Iwate University, Morioka 020-8551 Japan
Email: narita@iwate-u.ac.jp

It has been reported that excess heat has been observed in hydrogen (H) or deuterium (D) diffusion process with nano-composite particles of Pd-Ni and a nano-sized metal multilayer composite of Ni-Cu [1,2]. In addition, excess heat and helium generation have been reported in deuterium desorption process in a Pd foil coated with Au and metal oxide (MnO/SiO) membrane by Yamaguchi et al. [3]. These phenomena are supposed to be related to a low energy nuclear reaction in condensed matter. Although the reaction mechanism has not been clarified yet, it is considered that the sample conditions such as nanostructured-metal and the complex composition might be the keys for inducing the phenomena. We have conducted H/D desorption experiments using Pd-base metal complex samples, which were fabricated by depositing a metal membrane, such as Ni, Ag, Ti, and Zr, onto a Pd foil with a fine-structured surface. Systematic experiments with such various types of samples are expected to help elucidate the conditions under which excess heat is generated efficiently and the reaction mechanism.

In the experiment, the sample was fabricated by depositing a thin metal membrane by Ar ion beam sputtering onto one of the surfaces of the Pd foil with the size of 10 mm × 10 mm × 0.1 mm. The thickness of the membrane was ~100 nm. The fine-structured interface was formed by etching the Pd foil surface with an Ar ion beam before depositing the membrane. The fabricated samples were exposed to H/D gases at 5 atm for ~24 h for loading. The loading ratios were typically ~0.7. After loading, the sample was placed into a chamber evacuated by a Turbo-Molecular-Pump (~10^{-4} Pa). In the chamber, the sample was heated by applying a constant direct current (~0.75 A) to stimulate the H/D diffusion. The sample temperature and chamber pressure were continuously monitored for ~24 h. A thermo-couple and an infrared thermometer were used for the temperature measurement. The pressure inside the chamber was measured by an ionization gauge. The current and the bias applied to the sample were also recorded during the experiment.

We have observed intermittent exothermic phenomena with high reproducibility with a Pd coated with Ni membrane. The phenomenon has occurred in both H and D experiments. In addition, the voltage applied to the sample and the pressure inside the chamber changed simultaneously with the temperature. We now assume the following scenario to explain the behavior. After DC was applied to the sample, the sample temperature increased due to Joule heat, and loaded H/D diffused in the sample. Subsequently, H/D were densified near the sample surface and the electrical resistance of the sample surface increased. Since a constant current is applied to the sample, the voltage increased as a result. When the surface H/D density reached a certain level, the H/D desorbed and the pressure in the chamber increased, followed by a decrease in voltage. This characteristic H/D diffusion may be related to the condition of the Pd-Ni composite sample with fine-structured interface. We have estimated the excess power from the temperature measured and preliminarily obtained up to ~1 W so far. We are improving the accuracy of the excess heat estimation and will report the latest results.

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Strange Traces of a "Strange" Radiation

#Anatoly Nikitin, Vadim Nikitin,
Alexander Velichko, Tamara Nikitina,
V.L. Talrose Institute for Energy Problems of Chemical Physics
at N.N. Semenov Federal Research Center for Chemical Physics,
Russian Academy of Sciences, Moscow, Russia
Email: anikitin@chph.ras.ru

More than a quarter-century ago the traces were found on photographic films in the form of lines and prints of spherical objects tens of microns in size [1, 2]. These traces appeared near installations studying an electric discharge in water. It was found that the appearance of these traces is somehow connected with a change in the isotopic composition of the materials that were in the zone of contact with the particles of this "strange radiation" (LENR). Thanks to the work of many researchers, data were obtained on the typical marks of "strange radiation" [2- 5]. It was found that these particles, flying parallel to the film at a speed of 20-40 m/s, are able to create traces in the emulsion, the formation of which requires energy of 10^{10} eV [2, 4]. They deflected in a magnetic field. Their tracks looked like solid or dotted lines with complex relief. The most interesting was the discovery of "twin tracks", when a large number of absolutely identical tracks were observed on an area of about 1 cm^2 [3, 5]. Sometimes these traces had a chiral symmetry [3]. The report presents an overview of various theories of the structure of "strange" particles in the form of: magnetic monopoles [6], magneto-toro-electric radiation [7.], tachyons [4], compact pairs of electrons [8], "dark hydrogen" atoms [9] and multiply charged clusters [10]. It is analyzed how various theories manage to explain the structure of tracks of "strange" particles.

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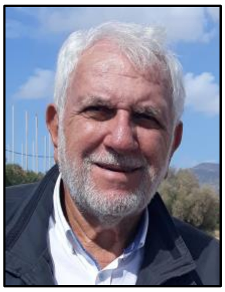
PAP-LENR Interpreting the process of generating low-energy nuclear reactions



Christos D. Papageorgiou
PAP-LENR inc.
Email: chrpapag@gmail.com

In 2008, as part of my research, I came across a theory where the unexplained cut in the middle of a conductor when it receives a sudden electrical pulse, challenged Maxwell's theory and beyond, the special theory of relativity with which is inseparably linked.
Having lectured Maxwell's theory for years, I could not resist the temptation and proceeded with a series of relative experiments that led to a Maxwellian interpretation of this phenomenon [1]
According to this interpretation, there is a transient concentration of free electrons near the centers of the used wires that create shear forces to the wire, which can even cut the wire for strong enough voltage pulses.
Furthermore, the free-electron transient concentration affects the nearby metallic lattice ions by a so-called Stark effect. Due to the Stark effect, the Coulomb barriers of the nearby lattice ions are weakened increasing the probability of nearby free electrons entering their nuclei (electron capture) transforming protons to neutrons, and consequently creating nuclear transmutations.
It is well known that if the electric pulses are strong, wire fragmentation appears, thus the phenomenon of separation of wires in two pieces cannot be studied. Using low-intensity pulses I was able to find that in the middle of the wire, the one receiving maximal interaction of free electrons and their Coulombic explosions, certain LENR phenomena could be generated.
I continued with thousands of experiments putting the wires in tubes with conductive liquids to find that the free-electron forces were transferred also in the liquids. Eventually, I found that transient pulses (PINCH) in conductive structures, wires, liquids, and Deuterium gases have a quantum origin and in addition, the geometry of the structure affects the intensity of the phenomenon [2]
An important conclusion drawn from this study pertaining to the effects of strong electric pulses in conducting structures is that the interpretation given to the so-called Pinch effect (Implosion or Bennett theory) is not adequate and should be combined with the initial quantum origin concentration of electrons in the centers of the used devices.
The implosions related to the so-called Pinch effects on special devices are related to the accumulation of free electrons, due to quantum mechanics, in the centers of the devices, The free-electron accumulation is probably responsible for the creation of initial nuclear reactions, due to the transformation of nuclear protons to neutrons and secondarily in several cases strong nuclear transmutation phenomena (fusion) are appearing due to the so-called Pinch effect.
Studying the phenomenon further, the recently disclosed explosions of Lithium batteries, even expired ones, that to my mind are spontaneous LENR phenomena, reinforced my research ideas about the possibility of using these results for LENR applications.
The PAP-LENR interpretation I believe will soon be able to demonstrate experimentally its validity when an input weak electric pulse on a proper small conducting curvilinear structure, will create an output LENR of many times the energy of the input pulse.

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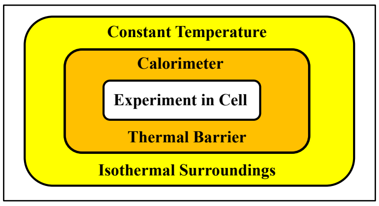
Transparent Isoperibolic Calorimeter for LENR Research

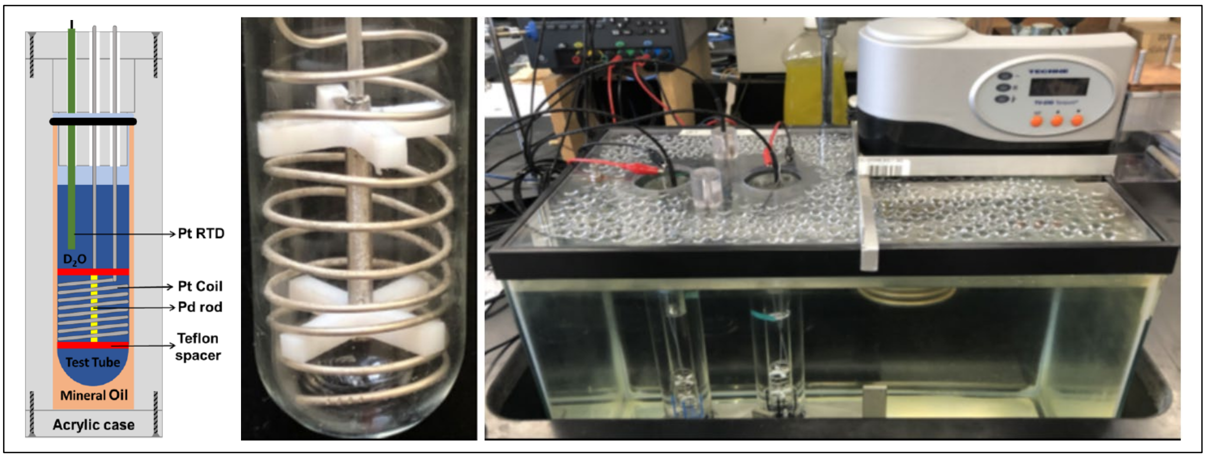
Chandraman Patil and David J. Nagel
George Washington University, U.S.A.
Email: chandramanpatil@gwmail.gwu.edu

Many types of calorimeters have been used during the one-third of a century of experimental research on the energy produced by Low Energy Nuclear Reactions (LENR). Isoperibolic calorimeters were employed by Fleischman and Pons [1], Miles [2] and many others to measure the power and energy from LENR in electrochemical experiments. The term "isoperibolic" indicates an isothermal and



constant ambient reference temperature outside of the calorimeter, which can be a gas (commonly air) or liquid (usually water). The calorimeter serves as a thermal barrier to power that is produced inside of the experiment due to electrolysis, and chemical or nuclear reactions. The calorimeter output is the temperature difference between the experimental cell within the calorimeter and the exterior temperature as a function of electrical power into the cell. We have designed, fabricated, calibrated and used a relatively simple cylindrical isoperibolic calorimeter, which is described in this paper.

The diagram on the left is a cross section of the calorimeter, which consists of a Lucite acrylic cylinder 50.8 mm OD and 25.4 mm ID, with Lucite end plugs, and mineral oil to thermally couple the test tube containing the cell to the Lucite. The 3 mm diameter by 30 mm long cathodes are held in place with Teflon crosses. Two such calorimeters are put in a water bath controlled to 30 °C, one with a Pt cathode and one with the cathode being studied. Temperatures are measured inside of the two cells, in the water bath and in the air, with a Pico Technology PT-104 Pt resistance sensor and data logger.



The transparency of this calorimeter permits one to view the bubbling near the electrodes and the electrolyte level during operation. The simple mechanical design makes fabrication and operation of the calorimeter relatively easy. Also, it is possible to calibrate the calorimeter in three ways: (a) measurement of the internal temperature of the cell for various values of the electrolysis power, (b) fitting of the time-dependent cooling curve, measured when the power is turned off, and (c) a simple calculation using the geometries and thermal properties of the component materials. The resulting values are comparable, and near 0.25 W per °C. The value is low compared to some LENR calorimeters, but still useful. The minimum detectable power value is near 20 mW, limited by electrical input noise due to bubbles, especially at high electrolysis powers. We have used electrical input powers up to 10 W.

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The Anthropocene Institute is thanked for support of this calorimeter development.

Studies of LENR Triggering Mechanisms Using Pressurized Nanoparticles

#Benjamin Peecher [1], George H. Miley [1]
[1] NPRE Department, University of Illinois, Urbana IL 61821
Email: bpeecher@industrialheat.co

This is a continuation of earlier work on LENR using pressurized metal hydride nanoparticles [1]. We hypothesize that, through material processing, we can create a metal oxide framework capable of being super saturated with hydrogen during a reduction reaction producing LENRs. The central concept is that hydrogen is packed into defects in the crystal lattice of metal hydride nanoparticles, enabling nuclear reactions. The reactor consists of two nested vacuum chambers with a heater coiled around the inner vacuum chamber, where the nanoparticles reside. Thermocouples are arranged in and around the particles for detecting excess heat.

Our goal is to maximize crystal defects in the metal hydride to provide a large number of reaction sites and then study various ways of triggering (imitating) reactions in the sites. We worked with PdZr and PdNiZr alloys of different ratios, and our procedure for fabricating a defect-rich metal oxide material included milling into powder using a liquid nitrogen cryo-mill. We hypothesize that keeping the material cold while milling will produce more nano-scale cracks and fissures to act as reaction sites.

We loaded this material into the reactor and exposed it to various triggering mechanisms. The simplest of these is to operate at higher temperatures. Some excess heat appeared to be produced above about 600 C, but the amount was too small to be definitive. Thus, several added approaches are under study. One method involved submerging a loop of wire in the vessel and pulsing current through it to trigger reactions via a small, pulsating magnetic field. We are also exploring use of electromagnetic pulses using a circuit capable of kilovolt nanosecond pulses. These experiments are ongoing, and the findings will be presented at the conference.

Acknowledgements: partial financial support by Industrial Heat, LLC is gratefully acknowledged. Design and provision of the nanosecond pulse board by Mark Snoswell is gratefully acknowledged.

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Validation of Excess Energy in the H_2 Loaded Palladium System

#Prahlada Ramarao[1], Shree Varaprasad N S,
Mohankumara P B, Shashank G Dath, Ankith Yenadka & Suprith G C
[1]Affiliation: Centre for Energy Research, S-VYASA University,
Jigani, Bangalore, Karnataka, India 560 105
#prahlada.ramarao@gmail.com

ABSTRACT

Energy Scenario is looking bleak for the upcoming generation with the near extinction of fossil fuels. There has to be a new breakthrough in the field of energy sector using alternate sources. LENR has the definite possibility to be that new source, if properly studied, experimented and engineered. There are many groups around the world pursuing this challenge to come up with a new variant of this energy source apart from the hydrocarbons or nuclear fission-based energy sources. A few of these groups have come up with interesting and promising results among which Centre for Energy Research (CER) at S-VYASA University, Bangalore, India [1] being one of them.

Absorption of Hydrogen/Deuterium into the metal lattice is one of the necessary conditions for LENR [2]. Metals like Nickel, Platinum, Titanium and specially Palladium have the ability to allow high levels of hydrogen loading into the lattice under controlled temperatures and pressures.

In this regard, two identical reactors were fabricated to perform the experiments with a unique loading protocol developed [3]. Both these reactors have the same thermal mass to negate the temperature ambiguities. One of these reactors has the active fuel component (active reactor) prepared using the hydrogen loading process whereas the other reactor (control reactor) is used as a control unit to confirm the generation of excess heat. All parameters have been made identical including set up and instrumentation.

Active reactor has shown higher skin temperature than the control reactor for the same power input demonstrating excess heat generated inside. This has been done several times in various modes and at different input power levels. These results were analysed and verified both experimentally and through thermal mathematical modelling. Efforts are being done to improve the efficiency.

Key Words: LENR, metal lattice, hydrogen loading, self-sustaining

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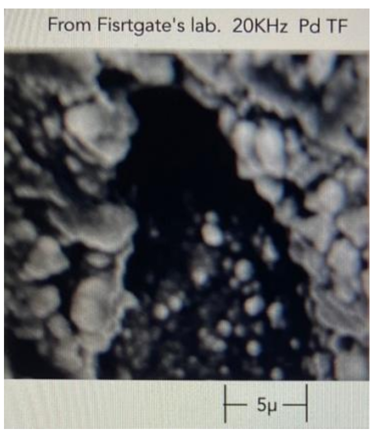
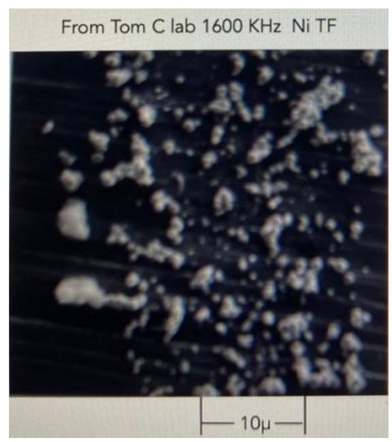
Cavitation and Frequency

Roger S. Stringham, USA
Firstgate
rogerssbiz@gmail.com

I started my cavitation work about 1977 and with the1989 Fleischmann and Pons announcement of desk top fusion, I realized that electrochemical bubbles and cavitation bubbles are related. I immediately tested that idea putting a Pd foil close to the surface of the cavitating 20KHz horn in DOD for 2 hours, which resulted in a deep blue and purple colored surface foil. I was hooked. From that moment on I invested my resources and energies on a path to Helium production. I started with a 20 Mhz device but wanted to look at higher frequencies and gambled on a 1,600 KHz device that was completed about the year 2005. Over the years the experimental frequencies studied were 20, 46, 1,600 and 2,000 KHz. The data gathering and analyses of these bubbling systems were similar. That is shown in two SEM photos Fig. 1 and 2 at 400 and 40 watts and frequencies of 20 and 1600 KHz. The resulting recondensed spheres appear the same for Pd with a 400-watt Ti horn and for Ni with a 40-watt 20 mm. Both showing the interaction produced from the bubble energetics. It is the small bubbles that are more dynamic bubbles that produce the He.





In 2010 I started working with a much in smaller device at higher frequencies. The SEM photos above show the same size of surface resolidified into micron spheres of target foil indicating similar energies. Over the years the cavitation input of 400 watts and 20 KHz were used [1]. The data always pointed to higher frequencies [2]. Around 2014 the higher frequency from a 20mm diameter x 2 mm thick PZT disk was driven by radio frequency amplifiers. These inputs were in the order of 50 watts and produced clouds of opaque bubbles in a 1-inch column Ar saturated DOD. The Ar gases collected samples in 50cc Pyrex bulbs from the Ar reactor gas phase were delivered to Tom Claytor and Malcolm Fowler for tritium and helium measurements [2]. 46 KHz target foil showed lattice implanted He4 measurements and no He3, 2011, by Brian Oliver at PNNL were 0.01 smaller than those measured by Malcolm Fowler in 2018 that were associated 6 watts heat measurements. Thanks to all my support and supporters. Ti foil lattice rejects He.

[1] R. Stringham, Helium measurements from target foils, LANL and PNNL, JCMS , Jean- Paul Biberian, 2017.

[2]T. Claytor, M. Fowler paper, Development of a Sensitive System for the Measurement of Trace Amounts of He4 in Deuterium or Hydrogen, ICCF 21 proceedings, Fort Collins, CO USA, 3-8 June 2018.

Impedance Spectroscopy Can Distinguish Active ZrO_2PdNiD NANOR®-type Components

Mitchell R. Swartz ScD, MD, EE
Nanortech, Inc. Wellesley Hills, MA, USA
mswartz@nanortech.com

Active aqueous and nanomaterial LANR materials have highly unusual electrical transconduction properties that accompany their excess-heat producing active states. The concern for these nanomaterials is the avalanche electrical breakdown which terminates the desired excess heat [1,2]. Therefore, we continue dielectric evaluations of active LANR systems to now include dry preloaded nanomaterials. Active LANR dry preloaded ZrO_2PdD and ZrO_2PdNiD NANOR®-type components were examined using dielectric spectroscopy [~10^{-4} Hz to ~2 GHz) and analyzed using Bode, Cole-Cole, Nyquist, and Smith Chart plots. Dielectric spectroscopy measures complex permittivity. Impedance is the ability to resist a force, such as an electric field intensity which has been applied to a material to cause electrically-induced flow of actual and potential charge carriers. Permittivity [3] is the ability of that material/system to energetically absorb some of the applied electrical force over a distance, which is then converted into an electric polarization. During this "relaxation" phase, the electrical dipoles align with the electrical field. The electrical impedance (inverse of conductivity) of a material is the imaginary part of the complex permittivity, and is linked to frequency. The rotations during relaxation are actually part of the electrical current, and so the real and imaginary parts of the complex permittivity are necessarily linked through Hilbert Space. As Fig.1 shows, dielectric spectroscopy uncovers information about a sample being examined. The results for active NANOR®-type dry, preloaded components reveal that there exist highly distinguishable differences. These patterns may result from many reasons including the electrical avalanches seen, and possible synchronized interactions between the loaded deuterons in vacancies, and other reasons ranging from material science to coupling and the transmission line. Thus, dielectric spectroscopy is an important nondestructive evaluation tool to evaluate LANR activity, material responses, breakdown and avalanche behavior, and quenching, including as a function of frequency.

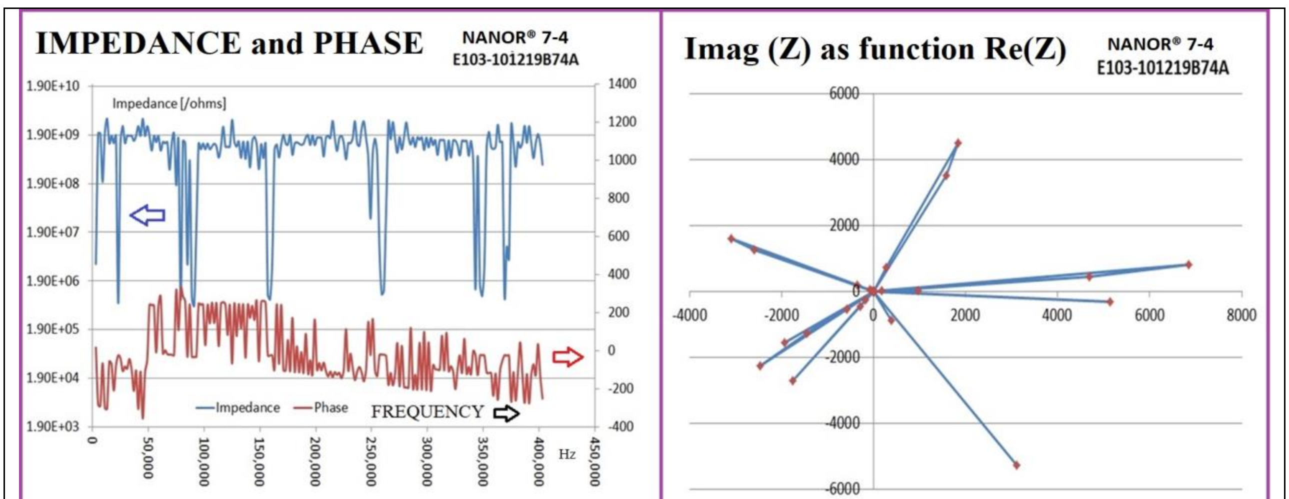


Figure 1 - Complex dielectric measurement of NANOR®-type component N7-4.
[left] Impedance and phase, as a function of frequency (a Bode plot).
[right] Imaginary part of the complex dielectric impedance as a function of the real part (a Nyquist plot).

[1] Swartz, M.R, Aqueous and Nanostructured CF/LANR Systems Each have Two Electrically Driven Modes, Proc. ICCF-21, Fort Collins, Co. 6/3/18 (2018), JCMNS, 29, 177 (2019).
[2] Swartz, M.R. P. Hagelstein, G. Verner, Impact of Electrical Avalanche Through a ZrO_2-NiD Nanostructured CF/LANR Component on its Incremental Excess Power Gain", JCMNS, 19, (2016).
[3] von Hippel, Arthur, Dielectric Materials and Applications, MIT Press. (1954).

Deuteron Momentum and the Umweg Factor Limit Successful CF/LANR

Mitchell R. Swartz, ScD, MD, EE
Nanortech, Inc. Wellesley Hills, MA USA
mswartz@nanortech.com

The use of dry preloaded ZrO_2PdNiD nanostructured materials in NANOR®-type components demonstrated the presence of unwanted Zener-type avalanche behavior during successful over-driven LANR. It immediately ends the excess heat as the component returns to prosaic V*I power dissipation. This paper further examines these critical electron breakdown processes. Deuteron momentum and scattering are most important because they initiate, and then limit the success of, CF/LANR activity.

V_D is the actual velocity of a deuteron. U_D – is the drift velocity. s – is the umweg (detour) factor; which equals the ratio of actual to drift velocities. τ_D - Time of free flight between collisions. Therefore, the Average # of collisions per unit length $\langle \# \text{ collision} \rangle_D = s / \langle \Lambda_D \rangle$ $\aleph$ -Fraction of kinetic energy lost per collision. μ_D - Effective electrophoretic mobility.	$U_D = \frac{1}{\tau_D} * \int_0^{\tau_D} \left[\frac{q\,E}{m_D} * t \right] dt$ $\overrightarrow{U_D} = \frac{-q}{2 * \sqrt{2 * m_D * k_B T}} * E = \mu_D * \vec{E}$

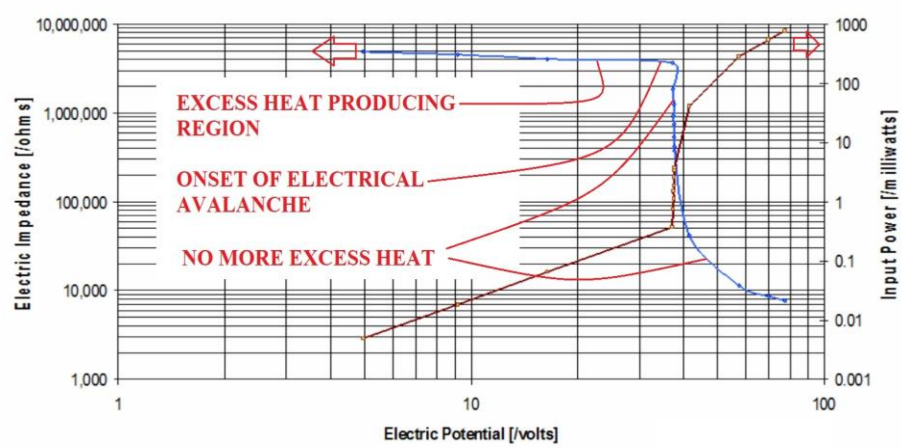
At nanoscopic equilibrium, the deuteron energy loss per collision balances the energy gained from the applied electric field.	$\frac{q * E * \langle \Lambda_D \rangle}{s} = \aleph * 1/2\ m_D * V_D^{\ 2}$

However, classical Ohm's law fails in ZrO_2PdNiD nanostructures because both the actual, and drift, velocities increase proportional to the applied E-field. In fact, this is what is seen [Swartz, M, Aqueous and Nanostructured LANR Systems Each have Two Electrically Driven Modes, JCMNS, 29, 177 (2019)].

$$V_D = - \sqrt{\frac{q\ \langle \Lambda_D \rangle\ E}{m_D}} * \sqrt{\frac{2}{[\ \aleph * s\,]}}$$

The deuteron temperature, Θ_D , in eV, can thus also be derived from the kinetic energy.

$$k_B * \Theta_D = 1/2\ m_D * \left\| \overrightarrow{V_D} \right\|^2 = \frac{q\ \langle \Lambda_D \rangle \left\| \vec{E} \right\|}{\sqrt{4 \aleph}}$$



Actual Zener-type electrical breakdown behavior in a dry preloaded, active LANR nanostructured NANOR®-type component ending the excess heat, and making the component act like an ohmic resistor, again.

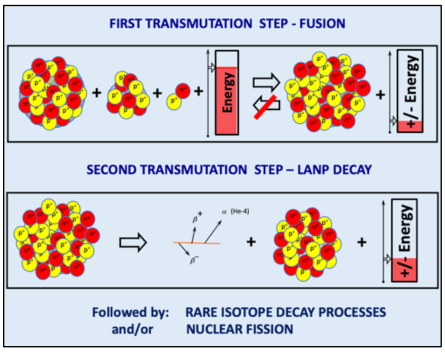
Calibration of an Electrode Energy Partition Model Using George Miley's Published Data

#Daniel S. Szumski[1]

[1] Independent Scholar, USA

Email: Danszumski@gmail.com

The single greatest need in cold fusion science is a scientific theory of its nuclear process fundamentals. It is only at this level of understanding that nuanced insights can be brought to electrode design and developing a commercial device. This goal is the essence of my research into the Least Action Nuclear Process [LANP] theory of cold fusion.



LANP theory is based exclusively in classical physics principles. In some instances, it derives new interpretations of physics, as is the case in its description of a far-from-equilibrium Theory of Heat, and it contention that Reversible Process dynamics are: 1) probably implicated in cold fusion's energy accumulation, and 2) its nuclear transmutations to stable isotope products without the expected radiation signature.

This poster presents the LANPDESIGN program. Its author demonstrates its use in simulating the appearance of new isotope products in George Miley's published transmutation experiment. The analysis also illustrates how known principles of physics might be used to specify the order of isotope appearance. A particularly important feature of the tabulated transmutation equations is the partitioning of the total energy change into its four components: 1) the initial fusion energy threshold, 2) LANP decay energy, 3) rare isotope decay, and 4) fission caused energy release. In essence, LANP theory illustrates how cold fusion might be a completely deterministic process, having no connection to the uncertainty principles of quantum mechanics.

While LANP theory constructs a plausible scientific framework for a cold fusion model, there are still many unresolved issues in the model's calibration. The theory seems to be able to match Miley's data with 90+% accuracy. Nevertheless, there are indications that the specificity of the theory might still not be accurately represented. This poster identifies alternative decay sequences which could be tested in subsequent editions of LANPDESIGN. However, our ability to verify most of these alterations to LANP theory is hampered by the absence of the required experimental measurements.

	FUSION REACTION			FUSION PRODUCT	LANP PRODCT	RARE DECAY	RARE DECAY PRODUCT	SPONT.	FISSION	PRODUCT	ENERGY COMPONENTS (amu) FUSION	LANP	RARE DECAY	FISSION	TOTAL
1	50Cr	+ 70Zn	+ (4)n =>	124Xe	=> 124Xe	=> B+B+	=> 124Te	=> SF	=> 62Ni	61Ni	0.00013	0.00000	0.00417	0.03146	0.03576
2	51V	+ 54Fe	+ (3)n =>	108In	=> 106Cd	=> B+B+	=> 108Pd	=> SF	=> 54Cr	54Cr	−0.00013	0.00496	0.00139	0.02503	0.03126
3	61Ni	+ 50Cr	+ (4)n =>	115Te	=> 115Sn			=> SF	=> 57Fe	57Fe	−0.00014	0.00746	0.00000	0.02170	0.02902
4	51V	+ 57Fe	+ (3)n =>	111In	=> 111Cd			=> SF	=> 55Mn	55Mn	0.00024	0.00147	0.00000	0.01613	0.01785
5	57Fe	+ 57Fe	+ (4)n =>	118Te	=> 118Sn			=> SF	=> 59Co	58Fe	−0.00038	0.00422	0.00000	0.02372	0.02757
6	52Cr	+ 52Cr	+ (3)n =>	107Cd	=> 107Ag			=> SF	=> 53Cr	53Cr	0.00039	0.00097	0.00000	0.01349	0.01485
7	52Cr	+ 54Cr	+ (3)n =>	109Cd	=> 109Ag			=> SF	=> 54Fe	52Cr	0.00040	0.00078	0.00000	0.00000	0.00118
8	50Cr	+ 57Fe	+ (3)n =>	110Sn	=> 110Cd			=> SF	=> 55Mn	54Cr	−0.00041	0.00484	0.00000	0.01467	0.01910
9	58Ni	+ 54Cr	+ (4)n =>	116Te	=> 116Sn			=> SF	=> 58Ni	57Fe	0.00042	0.00562	0.00000	0.02015	0.02619
10	54Cr	+ 54Cr	+ (3)n =>	111Cd	=> 111Cd			=> SF	=> 55Mn	55Mn	−0.00042	0.00000	0.00000	0.01613	0.01571
11	61Ni	+ 53Cr	+ (4)n =>	118Te	=> 118Sn			=> SF	=> 59Co	58Fe	0.00054	0.00422	0.00000	0.02372	0.02849
12	62Ni	+ 50Cr	+ (4)n =>	116Te	=> 116Sn			=> SF	=> 58Ni	57Fe	0.00059	0.00562	0.00000	0.02015	0.02636
13	60Ni	+ 50Cr	+ (4)n =>	114Te	=> 114Sn			=> SF	=> 57Fe	55Mn	−0.00060	0.00822	0.00000	0.00927	0.01688
14	51V	+ 70Zn	+ (4)n =>	125I	=> 125Te			=> SF	=> 62Ni	62Ni	−0.00069	0.00075	0.00000	0.03579	0.03584
15	64Ni	+ 52Cr	+ (4)n =>	120Te	=> 120Te	=> B+B+	=> 120Sn	=> SF	=> 60Ni	59Co	−0.00089	0.00000	0.00292	0.02681	0.02884
16	54Fe	+ 58Fe	+ (4)n =>	116Te	=> 116Sn			=> SF	=> 58Ni	57Fe	−0.00092	0.00562	0.00000	0.02015	0.02485
17	50V	+ 68Zn	+ (4)n =>	122I	=> 122Te			=> SF	=> 61Ni	59Co	−0.00093	0.00400	0.00000	0.01762	0.02069
18	50V	+ 70Zn	+ (4)n =>	124I	=> 124Te			=> SF	=> 62Ni	61Ni	0.00093	0.00284	0.00000	0.03146	0.03523
19	50V	+ 56Fe	+ (3)n =>	109In	=> 109Ag			=> SF	=> 54Fe	52Cr	0.00094	0.00240	0.00000	0.00000	0.00334
20	58Ni	+ 50Cr	+ (4)n =>	112Te	=> 112Sn	=> B+B+	=> 112Cd	=> SF	=> 56Fe	55Mn	−0.00096	0.01110	0.00316	0.01727	0.03056

Prompt Gamma Radiation Measurements in Brillouin's Reactor

#Francis Tanzella[1], Robert Godes[2], Robert George[2]
[1] Energy Research Center, USA
[2] Brillouin Energy Corporation, USA
Email: consulting@tanzella.name

A campaign was undertaken to attempt to elucidate the mechanism of energy production in Brillouin's hydrogen hot tube (HHT) reactor using modified catalyst tubes. The controlled electron capture (CECR) hypothesis suggest that neutrons are an intermediate species in the reaction chain leading to the formation of He-4 with a commensurate release of energy. The hypothesis can be shown to be possible by detecting the presence of neutrons simultaneous with the production of excess heat. The simplest method to detect neutrons is with the use of a large neutron capture cross section material in the presence of a gamma spectrometer (*i.e.* prompt gamma detection).

The catalyst tubes, installed in the axial center of the reactor's gas sheath, consist of a substrate with several spray-coated layers[1]. For this test, the inner layer was copper, coated with sprayed alumina, over which was the active nickel layer. All the layers are porous, allowing the gas(es) in the reactor chamber access to all coatings. Indium metal, the neutron capture medium, was applied either below or on top of the Ni layer. The outer active Ni layer of the reactor tube is stimulated by sending pulses[2] between it and the innermost Cu layer. Calorimeteric measurements are described elsewhere[1]. Figure 1 shows a schematic diagram of the reactor/ calorimeter used in these measurements.

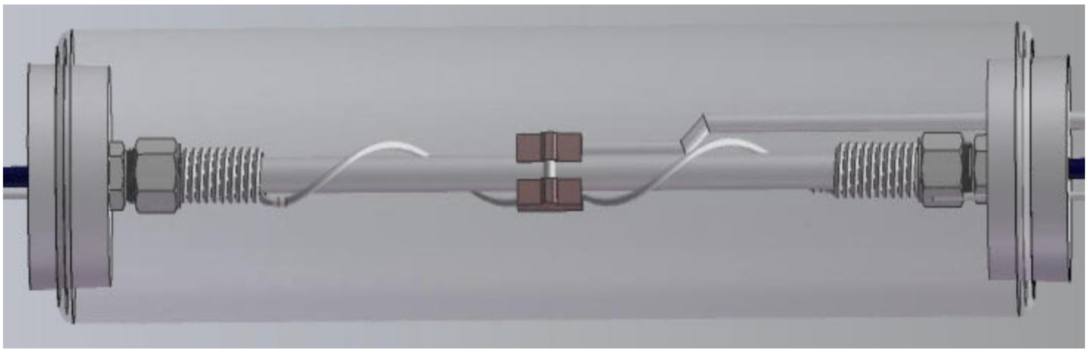


Figure 1. Schematic diagram of reactor/calorimeter system

The gamma spectrometer used for these measurements is a model GSB-2020-NAI, utilizing a 2" x 2" NaI(Tl) crystal, from Gamma Spectacular (Alexandria NSW, Australia). After measuring ambient background with and calibration spectra, gamma spectra were collected while stimulating the tube with different high voltage pulses. Attempts were made to correlate changes in the spectra with different pulse parameters. Simultaneously calorimeter measurements to determine the amount of excess power, if any, was measured.

Results of the different types of pulse stimulation used and calorimetry recorded will be presented. Also, background, calibration, and foreground gamma spectra will be presented and correlated with both pulse stimulation and the reactor's output power.

[1] R. Godes, R. George, and F. Tanzella, "Nanosecond pulse stimulation in the Ni-H_2 system", J. Condensed Matter Nucl. Sci, vol. 29, pp. 202-210, 2019.
[2] R. Godes, "Drive circuit and method for semiconductor devices", US Patent 8,624,636, 2014.

Formation of primary helium in the Earth

Gennady Tarassenko, Elena Demicheva, Matvey Tarassenko
Caspian State University of Technology and Engineering named after Sh.Yesenova, Kazakhstan, tarasenko-genadi@mail.ru

The earth has a layered internal structure with crust, upper mantle, mantle transition zone, lower mantle, outer core and inner core from the surface to the center. At the stage of the formation of the Earth, subduction zones appeared, through which all sedimentary strata formed on the surface were constantly fed, and such a process is constant in modern times. In this process of separation of the core and the mantle, the separation of inert gases between the core and the mantle occurred. Noble gases, including helium, neon and argon, are characterized by high chemical inertia, which causes low reactivity with other materials and high volatility. Among them, 3 He, 20 Ne and 36 Ar are special isotopes that were components of the primary solar nebula that existed in space before the formation of the Earth as a result of the Big Bang.

The outer core, consisting mainly of plasma, is a candidate for a reservoir of primary helium, and there is a possibility that helium flows from this region into the mantle. Such noble gases could be brought to the surface due to the rotation of the geospheres from the plasma core. Therefore, it is difficult to exclude the possibility that the core is a reservoir of inert gases. If noble gases prefer metals when pressure increases (a property called siderophile), more may be dissolved in the core, and it is important to find out the separation properties of noble gases. Precise experimental measurements of the distribution of elements under high pressure are quite difficult, so in this study, using quantum mechanical computer modeling technology, the properties of the distribution of helium and argon between liquid iron and molten silicate were determined.

By comparing these reaction energies, it is possible to estimate the relative differences in the equilibrium concentrations of inert gases in coexisting liquid iron and molten silicate. Based on the fundamental principle of thermodynamics, noble gases dissolve more in a solvent with a lower reaction energy, and thus large differences in reaction energies further enhance the contrast in the concentrations of inert gases in liquid iron and molten silicate. Special methods are required to calculate the reaction energy of inert gases with liquids such as liquid iron and molten silicate. Despite the fact that 100 times more helium was dissolved in the magma ocean, most of it would evaporate into the air while it solidified, and due to its high volatility, only insignificant amounts would remain. On the contrary, helium dissolved in the core during the rotation of the core gradually gave it away in the ground and up to the surface. There are no strong pressures there, they were formed due to electricity and gravity plays the role in the core. Helium can be measured in water wells, which indicates its presence on Earth. These results strongly confirm that the 3He reservoir is located in the core. This is important information about the location of the primary reservoir, one of the long-standing mysteries in Earth sciences.

We conducted experiments with propane and helium. It turns out the same blue color of the plasma and when the voltage was turned off in helium, the installation worked for 16 seconds, and in propane we marked the time up to 63 seconds. Now we need to think about the composition of gases together with helium, neon, argon, maybe we can make a small "Big Bang".

EVALUATION OF THE POSSIBILITY FOR USING THE HELIUM LEAK DETECTOR TI1-14 FOR THE ANALYSIS OF PROTIUM H_2, DEUTERIUM D_2, HELIUM-3 $_3He$ AND TRITIUM T_2.

Sergei A. Tcvetkov[1], Konstantin V. Fedko[2]
[1] Independent consultant on cold fusion (LENR), RUSSIA
[2] Mass Spectrometric analyst, RUSSIA
Email: rossomahi@gmail.com

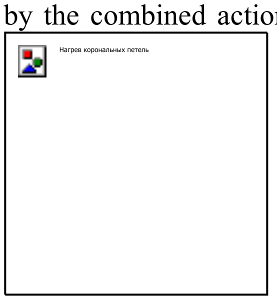
The characteristics of the TI1-14 helium leak detector are given. The possibility of registering the listed nuclear fusion products based on the interaction of hydrogen isotopes using its sensor is evaluated. The results of calibration of the leak detector by helium are given. And the results of measuring hydrogen and the supposed products of nuclear fusion during the electrolysis of solid proton-conducting electrolytes in the deuterium atmosphere.

LENR solution for fundamental mysteries of the solar corona (anomalously high temperature and anomalous He^3 concentration)

#V. I. Vysotskii[1], M. V. Vysotskyy[1], Sergio Bartalucci[2],
[1]Taras Shevchenko National University of Kyiv, Kyiv, 01601 Ukraine
[2]INFN Laboratori Nazionali di Frascati, Frascati, 00044 Italy
vivysotskii@gmail.com

Among the fundamental mysteries of modern astrophysics and the Sun physics, one of the most mysterious is the problem of the anomalously high temperature of the solar corona surrounding the visible Sun surface (photosphere) with the temperature 5780 K. Above the surface of the photosphere there is a thin (about 10^3 km) layer of the chromosphere, near the outer surface of which (at the bottom of the solar corona) the temperature increases to $1.5*10^6$K in the range of 100-300 km, which contradicts all the laws of thermodynamics. Multiple attempts to explain these phenomena have not been successful. Another mystery is related to the anomalously high concentration of He^3 isotope relative to He^4 in solar flares compared to the usual 0.0004 ratio. The observed increase in this ratio reaches 10 and much more times cannot be explained on the basis of the available data on processes on the Sun.

The report shows for the first time that these mysteries can be successfully solved by LENRs stimulated by the combined action of a magnetic field and spatial nanodynamics of low-temperature plasma. It is



well known from astronomical observations that in this part of the Sun, very frequent vertical ejections of gas-plasma magnetized substance (spicules) occur from the volume of the photosphere, stimulated by fast switching (reconnections) of the magnetic field. At the same time, there are about 10^6 such spicules on the Sun. They move with an initial speed of 20–50 km/sec, have a diameter of 200–2000 km, an average lifetime of 5–7 min, and rise above the chromosphere to the lower part of the solar corona to a height of $(6 \div 10)*10^3$ km. Inside the spicules, there is a magnetic field $H \approx 2 \div 3$ kOe. The typical spicules composition is a weakly ionized "standard" Sun gas at $T \approx 10^4 K$ with atomic and electron (ion) concentrations $n_0 \approx 10^{15} \div 10^{17} cm^{-3}$, $n_{e,i} \approx 10^{11} \div 10^{13} cm^{-3}$. For such parameters, "standard" nuclear fusion is impossible. Our calculations [1] show that taking into account the nanodynamics of a magnetized partially ionized plasma with such parameters leads to a very frequent change $(dW_H / dt = dW_p / dt \sim 10^6 \div 10^8 \sec^{-1})$ in the probabilities $W_{H,p}$ of charge states (ionization and recombination) of hydrogen atoms and protons $H \leftrightarrow p + e$. Such processes of frequent "turning on" of the charge in the presence of a magnetic field lead to the formation of coherent correlated states of protons, the generation of giant energy fluctuations $\delta E \approx 10 \div 100 keV$ [2], and realization of effective LENR in the upper part of solar spicules based on $p + d = He^3$ reaction with efficient energy release and creation of He^3 isotope. In the cases where such spicules have a very high initial speed, their motion after leaving the solar atmosphere corresponds to a cosmic ray flux with an anomalous ratio of helium isotopes. Similar processes of the realization of a "flashing" $p + d = He^3$ LENR also correspond to another type of solar activity: the formation of magnetized low coronal solar loops.

[1] V. I. Vysotskii, M. V. Vysotskyy, "Self-similar mechanism of repeatedly flashing LENR in a magnetized partially ionized gas (warm plasma)", Report at ICCF-24, 2022.

[2] V.I.Vysotskii, M.V. Vysotskyy. “Coherent correlated states and low-energy nuclear reactions in non stationary systems”. European Phys. J. A, vol.49, issue 8: 99, pp.1-12, 2013.

Undamped thermal waves and peculiarities of pulsed LENR and thermally stimulated biochemical reactions in the interaction of viruses with cells

D.Ya. Agasarov, I.V.Kornilov, M.A.Gerasimov,
#V.I.Vysotskii, A.A.Kornilova, S.N.Gaydamaka
AVSystems Inc. (54, Harpsichord TPKE, Stamford, CT, 06903, USA)
vivysotskii@gmail.com

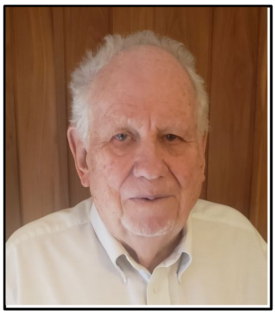
The report relates to the medical application of undamped temperature waves, whose action leads to the stimulation of nuclear and atomic transformations in viruses and critical objects of living matter.

The features of excitation, propagation over long distances, and the action of non-dissipative (undamped) high-frequency temperature waves are considered in connection with their influence on the efficiency of the system for remote recognition of critical cells by viruses. It is shown that the action of such waves leads to screening of critical cells due to a change in the atomic-molecular structure of their surface, which leads to a significant change in the dispersion and other electromagnetic characteristics of these cells. Such changes lead to a very strong weakening of the efficiency of the system of remote recognition of such cells by viruses, which corresponds to the effective "passive" self-defense of the human body and blocking the activity of viruses.

It has also been shown that exposure to such temperature waves can be an "active" method of self-defense of the body, reconfiguring the virus recognition system to extraneous (non-critical) cells or other macrocomplexes. In this case, the result of the attack of the virus will be the mutual destruction of the "false target" and the virus due to the natural apoptosis of this non-critical object when the virus penetrates into it.

An additional mechanism for the active antiviral effect of such waves is associated with the stimulation of a number of nuclear transmutation reactions involving isotopes of the basic chemical elements H, C, N, O in the remote virus recognition system.

LEC Conduction Analysis Including Diffusion of Ions



Harper J Whitehouse [1], #Frank E Gordon [2]
[1] InovL, Inc, USA
[2] InovL, Inc, USA
Email: feg@inovl.com

Experimentation has shown that Lattice Energy Conversion (LEC) performance is strongly dependant on the diffusion of ions in ambient pressure ion-ion plasmas of LEC devices. This dependence is expected to substantially influence the design and performance of LEC devices. For example, depending on the source and type of ionizing radiation, ionization is expected to increase as the number-density (fill-pressure) of the gas is increased. Since ion diffusion contributes a substantial part of the electrical power in a spontaneously conducting LEC its optimization is of primary importance. This diffusion contribution usually has been neglected, in the analysis of the conduction of electricity through gases,[1] since it significantly complicates an already difficult analysis. Including the diffusion of ions, raises the order of the differential equation for the electric field distribution from a 2nd-order non-linear differential equation to a 4th-order non-linear differential equation that must be solved by numerical integration[2].

In this presentation an alternative successive approximation analysis procedure is developed based upon the seldom cited 1903 publication of Eduard Riecke[3]. An English translation of this publication now is available as an appendix[4]. In this alternate approach the multiple differential equations, using more LEC appropriate initial and boundary condition, are solved successively to yield an estimate of the square of the electric field distribution. After solving for the square of the electric field distribution, an important consideration is that the electric field and its reciprocal can be found either analytically or numerically. The spatial distributions of the positive and negative ions now can be found as well as estimates of the distribution of ionization within the gas as well as the loss of ionization by ion-ion recombination. Examples for a LEC cell with a working electrode of electrochemically co-deposited palladium (Pd) from light water (H_2O) and using deuterium (D_2) gas will be shown. A similar cell has been in continuous operation for over 8 years with only a couple of fillings with deuterium gas.

The importance of these findings are that the physical position and separation of the electrodes depend on both the type of ionizing agent or agents as well as the distribution of the ions in the gas. For heavy particles, such as protons and α-particles, large electrode spacings are appropriate while for light electrons the electrodes may be closer together. Thus, it is important to determine the distribution of ions within the gas and the role that electrode shape and position have in LEC design. The differential equation system to be solved is shown using rationalized CGSA units.

By using successive approximation, the 4th-order nonlinear differential can be replaced by a set of differential equations no higher than 2nd-order. These equations have analytic solutions in contrast to the 4th-order equation which can only be solved by numerical computation. By using the measured parameters, voltage and current, ionization rate and ion density between the electrodes can be estimated. This information will be critical in providing guidance in scaling up the output of the LEC.

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Reproduction of excess heat using a Pd-B cathode measured by Seebeck calorimeter

Wu-Shou Zhang

Institute of Chemistry, CAS, Beijing, China

Email: wszhang@iccas.ac.cn

Clear excess heat using a cathode of Pd-B alloy rod (ϕ4.71 mm × 2 cm) provided by Melvin H. Miles [1] was measured by a Seebeck calorimeter after 18 runs of D_2O electrolysis (0.17 to 0.75 A, 828.5 h totally) over one year. As shown in Fig. 1, a reflux open-electrolytic cell similar to that reported in ICCF23 is used [2]. The merit of the cell is that the evaporation power of heavy water is a small constant during electrolysis ($P_{vapor} = 0.00979I$ at 25°C, the temperature of circulating bath of Seebeck calorimeter) and the calorimetry is simplified therefore. A comparison of the excess heat between 2 runs before and after around one year is shown in Fig. 2. It seems that Pd cathode must be activated by long time electrolysis. The cathode can produce excess heat after activated.

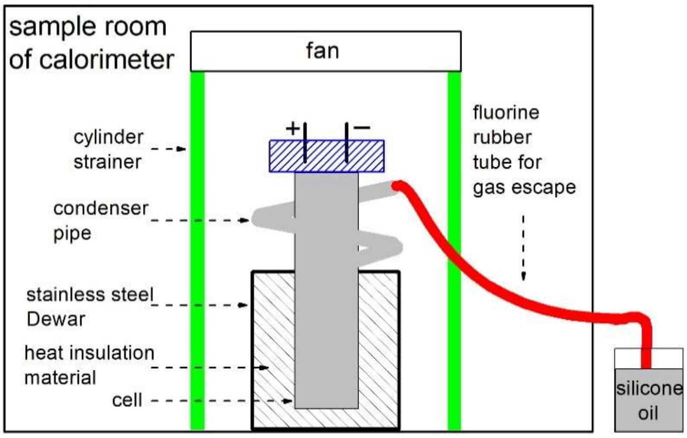

Fig. 1. The schematic of reflux open-electrolytic cell in Seebeck calorimeter.

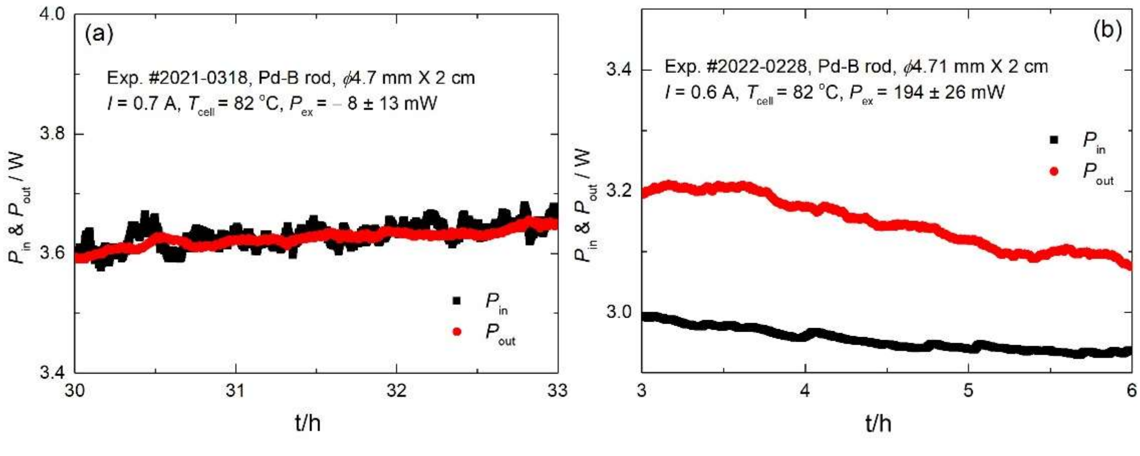

Fig. 2. (a) Exp. #2021-0318, no excess heat was produced and the Pd-B cathode was not active at that time; (b) Exp. #2021-0228, stable and sustained excess heat was produced, indicating that Pd-B cathode was active. The latter has lower current and input power than the former although their values of cell temperature are the same, which also indicates the production of excess heat in the latter.

References

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