

**14th International Conference on
Condensed Matter Nuclear Science**

**14th International Conference on
Cold Fusion**

**Exciting New Science
Potential Clean Energy**

Agenda and Abstracts

**Hyatt Regency on Capitol Hill
Washington DC
10-15 August 2008**

	Sunday 10 Aug	Monday 11 Aug	Tuesday 12 Aug	Wednesday 13 Aug	Thursday 14 Aug	Friday 15 Aug
800						
		Keynote Introduction Preview	Gas & Fast Loading	Transmutations	Theory	Experimental Reports
1000		Break	Break			
		Heat Results	Honoring Arata	Break		
			Honoring Szpak	Country Histories	Beam Probe Experiments	Summary & Two Panels
1200		Lunch			Lunch	
		Measuring Heat	Particle Measurements	Box Lunch	Theory	Transmutation Workshop
200		Break		Excursion	Break	
	Initial Registration	Materials	Challenges		Materials and Optical	
400		Posters			Posters	
600			ISCMNS Meeting			
800	Reception			Banquet		
1000						

14th International Conference on Condensed Matter Nuclear Science
14th International Conference of Cold Fusion
 Hyatt Regency on Capitol Hill
 Washington DC

Sunday 10 August 2008

1500-1900	Registration	Ballroom Foyer (Lower Level)
1900-2100	Reception	Columbia Ballroom (Lower Level)

Monday 11 August 2008

0730-0830	Daily: Registration in the Ballroom Foyer (Lower Level) and Continental Breakfast in the Hall of Battles (Lower Level)	
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Opening Session
Ballroom (Lower Level)

			Number
0830-1000	Llewellyn King	Keynote Address	1
	D. J. Nagel	Problems, Progress and Prospects	2
	M. E. Melich	Conference Preview	3

1000-1030	Morning Break in the Hall of Battles (Lower Level)	
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Heat Results
 Chairmen: M. Srinivasan and Y. Kim

1030-1100	D. Cravens and D. Letts	The Enabling Criteria of Electrochemical Heat: Beyond Reasonable Doubt	4
1100-1130	M. Swartz	Excess Power Gain and Tardive Thermal Power Generation using High Impedance and Co-depositional Phusor™ Type LANR Devices	5
1130-1200	S. Lesin, <i>et al.</i>	Ultrasonically-Excited Electrolysis Experiments at Energetics Technologies	6

1200-1330	Lunch	Congressional Room (Lobby Level)
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Measuring Heat
 Moderator: B. R. Breed

1330-1500	J. Dufour, <i>et al.</i>	Ice Calorimetry	7
	M. Eisner	Heat Flow Calorimetry	8
	M. C. H. McKubre	Mass Flow Calorimetry	9
	M. H. Miles and M. Fleischmann	Isoperibolic Calorimetry	10
	E. Storms	Seebeck Calorimetry	11

1500-1530	Afternoon Break in the Hall of Battles (Lower Level)		
Materials Chairmen: A. Takahashi and S. Chubb			
1530-1600	V. Violante, <i>et al.</i>	On the Correlation of PdD Alloy Material Properties with the Occurrence of Excess Power	12
1600-1620	I. Parchamazad, <i>et al.</i>	Investigations of Nanoparticle Palladium/Deuterium Systems in Zeolites	13
1620-1640	J. Marwan	Study of the Nanostructured Palladium Hydride System	14
1640-1700	T. Nohmi, <i>et al.</i>	Basic research on condensed matter nuclear reaction using Pd powders charged with high density deuterium	15
Poster Session and Book Sales			
1700-1800	Posters	Lexington and Concord Rooms	
1700-1800	Book Sales	Reception Desk in the Ballroom Foyer (Lower Level)	
Tuesday 12 August 2008			
Gas and Fast Loading Chairmen: K. P. Sinha and D. Cravens			
0830-0900	J.-P. Biberian	Cold Fusion by Gas Loading: A review	16
0900-0930	F. Celani, <i>et al.</i>	Deuteron electromigration in thin Pd wires coated with nano-particles: evidence for ultra-fast Deuterium loading and anomalous, large thermal effects	17
0930-1000	Morning Break in the Hall of Battles (Lower Level)		
Honoring Yoshiaki Arata Organizer: T. A. Chubb			
1000-1030	T. A. Chubb	In Honor of Yoshiaki Arata	18
1030-1100	Y. Arata and Y.-C. Zhang	"Solid Fusion" Reactor with Zero Input Energy	19
Honoring Stanislaus Szpak Organizer: F. E. Gordon			
1100-1200	S. Szpak, P. Mosier-Boss, F. Gordon, M. Miles and L. Forsley	LENR Research Using Co-Deposition	20
1200-1330	Lunch	Congressional Room (Lobby Level)	

Particle Measurements			
Chairmen: X. Z. Li and R. E. Smith			
1330-1400	A. G. Lipson, <i>et al.</i>	Charged Particle Emission During Electron Beam Excitation of Deuterium Subsystem in the Pd and Ti-Deuteride Targets	21
1400-1430	E. Storms and B. Scanlan	Detection of Radiation Emitted from LENR	22
1430-1500	R. Oriani	Reproducible Evidence for the Generation of Nuclear Particles During Electrolysis	23
1500-1530 Afternoon Break in the Hall of Battles (Lower Level)			
Challenges			
Chairmen: Y. Iwamura and E. Storms			
1530-1600	M.C.H. McKubre, <i>et al.</i>	The Importance of Replication	24
1600-1630	Y. Toriyabe and J. Kasagi	Development of New Detector System for Charged Particle Emission	25
1630-1700	D. Kidwell	Considerations for Ultra-Trace Analysis of Metals in a Palladium Matrix	26
Poster Session and Book Sales			
1700-1800	Posters	Lexington and Concord Rooms	
1700-1800	Book Sales	Reception Desk in the Ballroom Foyer (Lower Level)	
1800-2000 Annual General Meeting of the ISCMNS in the Ballroom (Lower Level)			
Wednesday 13 August 2008			
Transmutations			
Chairmen: A. Kornilova and V. Vysotskii			
0830-0900	Y. Iwamura, <i>et al.</i>	Transmutation Reactions Induced by D ₂ Gas Permeation through Pd Complexes (Pd/CaO/Pd)	27
0900-0920	T. Yamaguchi, <i>et al.</i>	Investigation of Nuclear Transmutation Using Multilayered CaO/X/Pd Samples Under Deuterium Permeation	28
0920-0940	T. Hioki, <i>et al.</i>	Influence of Deuterium Gas Permeation on Surface Elemental Change of Ion-Implanted Pd	29
0940-1000	J. Dash and Q. Wang	Elemental Mapping on the Surfaces of Palladium Cathodes after Electrolysis	30
1000-1030 Morning Break in the Hall of Battles (Lower Level)			

Country Histories			
Chairmen: W. Collis and T. Passell			
1030-1045	X. Z. Li	China - Condensed Matter Nuclear Science Research in China	31
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1130-1145	J. Kasagi and Y. Iwamura	Japan - Country History on Japanese Work on Cold Fusion: Towards further development of Condensed Matter Nuclear Science	35
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1230	Depart for Tour with Box Lunches on the Bus		
About 1330	Arrive at the Udvar-Hazy Center of the Smithsonian Air and Space Museum		
1630	Depart from the Udvar-Hazy Center of the Smithsonian Air and Space Museum		
About 1730	Arrive at the Hyatt Regency Hotel on Capitol Hill		
1900	Conference Banquet and Award Ceremony in the Regency Ballroom (Lower Level)		
Thursday 14 August 2008			
Theory			
Chairmen: V. Violante and A. Imam			
0830-0900	P. L. Hagelstein, et al.	Physical Mechanisms in Theories of Condensed Matter Nuclear Science	38
0900-0915	X. Z. Li, <i>et al.</i>	Exploring a Self-Sustaining Heater without Contamination	39
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0930-0945	S. R. Chubb	Resonant Electromagnetic Dynamics Explains the Fleischmann-Pons Effect	41
0945-1000	M. Swartz	Optimal Operating Points in Active, Loaded Palladium Linked to Three Distinct Physical Regions	42
1000-1030	Morning Break in the Hall of Battles (Lower Level)		
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Chairmen: I. Savvatimova and J. Dash			
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1130-1200	K. Czerski, <i>et al.</i>	The D-D threshold resonance and enhanced electron screening	45
1200-1330	Lunch	Congressional Room (Lobby Level)	

Theory

Chairmen: J. Dufour and M. H. Miles

1330-1345	K. P. Sinha and A. Meulenberg	A theoretical model for enhanced fusion reaction in metal deuterides in the solid matrix	46
1345-1400	A. Takahashi	Dynamic Mechanism of TSC Condensation Motion	47
1400-1415	R. W. Bass and M. Swartz	Empirical System Identification (ESID) and Optimal Control of Lattice-Assisted Nuclear Reaction (LANR) Devices	48
1415-1430	A. Marmigi, <i>et al.</i>	The SHEEN Project: Theoretical Model on the hydrogen dynamics in CMNS experiments	49
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1445-1500	D. Alexandrov	Pairing Interactions between Positive Nuclei Incorporated in Solid Structures	51
1500-1530	Afternoon Break in the Hall of Battles (Lower Level)		

Materials and Optical Measurements

Chairmen: T. Zilov and M. B. Miller

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1620-1640	K. Tsuchiya, <i>et al.</i>	Observation of Optical Phonon in Hydrogen Storage Pd Using Raman Spectroscopy	54
1640-1700	M. Swartz, <i>et al.</i>	Non-Thermal Near-IR Emission Linked with Excess Power Gain in High Impedance and Co-deposition Phusor™ Type LANR Devices	55

Poster Session and Book Sales

1700-1800	Posters	Lexington and Concord Rooms	
1700-1800	Book Sales	Reception Desk in the Ballroom Foyer (Lower Level)	

Friday 15 August 2008

Experimental Reports

Chairmen: J. Kasagi and D. Letts

0830-0845	A. Kornilova, <i>et al.</i>	Investigation of Radiation Effects at Bubble Cavitation in Running Liquid	56
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0845-0900	R. Stringham	Bubble Driven Fusion	57
0900-0915	J. Tian, <i>et al.</i>	Excess Heat Triggering by Nd:NYW Laser in a D/Pd Gas-Loading System	58
0915-0930	T. Mizuno, <i>et al.</i>	Heat Generation during Hydrogenation of Carbon (Phenanthrene)	59
0930-0945	A. B. Karabut and E. A. Karabut	Electric and Heat Measurements in High Voltage Electrolysis Cell Experiments	60
0945-1000	L. Forsley and P. Mosier-Boss	Quantitative Spatial Analysis of Pd/D Co-Deposited Induced Nuclear Particle Tracks	61
1000-1030 Morning Break in the Hall of Battles (Lower Level)			
Conference Summary and Panel Discussions Chairmen: J.-P. Biberian and M. C. H. McKubre			
1030-1100	Conference Summary	M. E. Melich and T. Passell	
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1130-1200	Panel	Realizing the Promise	
1200-1330 Lunch Regency Ballroom (Lower Level)			
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1330-1350	G. H. Miley	Introduction and Brief Overview of the Field	
1350-1430		Short Presentations & Discussion of Prior Experiments	
1430-1445 Afternoon Break in the Hall of Battles (Lower Level)			
1445-1525		Short Presentations & Discussion of Theory	
1525-1605	Panel	Discussion of Key Issues for Experiments and Theory, and Future Directions	
1605-1645	Panel	Discussion of Scientific Implications and Potential Commercial Applications	
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Keynote Address

Llewellyn King

The Fleischmann-Pons Effect: Problems, Progress and Prospects

David J. Nagel

General Chairman

14th International Conference on Cold Fusion

Study of the Fleischmann-Pons Effect started poorly almost twenty years ago. Scientific, technical, procedural and other problems burdened the field from the outset. Currently, imperfect reproducibility, lack of a complete theory, inadequate funding, limited communications and problems with securing patents still challenge what is an intrinsically interdisciplinary and actually quite complex subject.

Despite such difficulties, there has been remarkable scientific progress on the study of the FPE in the past two decades. Experiments in China, France, India, Italy, Japan, Russia and the United States, as well as in other countries, have been very productive. Now, many of the characteristics of the FPE are known empirically. High quality data with very good signal-to-noise ratios, published in over one hundred reports, shows that it is indeed possible to induce nuclear reactions at ordinary temperatures and energies. The reactions can involve the transmutation of heavy elements, as well as reactions of only light elements ordinarily of concern for fusion. There are strong indications that the nuclear reactions occur on the surface of solid materials. Connections between the FPE and nanotechnology are increasingly evident, but the tools of nanotechnology have not yet been widely brought to bear on the FPE because of funding limitations.

Data on the FPE from diverse experiments is widely available in conference proceedings, on the web and in some scientific journals. Examination of that data convinces more and more people that the FPE is now a legitimate field of science, and not only a collection of mistakes. It is now unclear if the FPE will be the basis of commercial products. However, some start-up and larger companies in the US and elsewhere are now working on the science in anticipation of manufacturing power sources for sale. Production of energy without significant prompt radiation or residual radioactivity is a very strong motivator. It is possible that power sources varying from a few watts for portable electronics to kilowatts for home and mobile applications will result from the current research. Beyond the need for scientific understanding, current challenges include reproducibility, controllability, optimizations, scaling and reliability. It seems to most researchers dealing with the FPE that the field should be receiving significant support at a time of great concern and large impacts of rising energy costs.

ICCF-14: A Conference Preview

Michael E. Melich

W.E. Meyer Institute of Systems Engineering

Naval Postgraduate School, Monterey, CA 93943

The first two days of this conference have been organized to give attendees who have not been following the research on Condensed Matter Nuclear Science an opportunity to understand the breadth and depth of work done since 1989. On each day of the conference reports of recent investigations are presented with the more specialized work filling the final three days of the conference. For ICCF-14 the organizers have commissioned topical reviews as well as invited eight countries to write the history of research in the language of their country. On Wednesday morning a brief synopsis of the country histories of CMNS in China, France, India, Italy, Japan and Russia will be presented. Topical reviews on the evidence for the Fleischmann-Pons Effect, the measurement of heat in an FPE experiment, the mechanisms found in theoretical investigations of the CMNS experiments, and the gas loading of palladium with deuterium and similar gas loading experiments are presented. On the final morning of the conference there will be two sessions. The first will summarize the research results presented during the week and the second panel will be a panel discussion of the future direction of the CMNS field.

The Enabling Criteria of Electrochemical Heat: Beyond Reasonable Doubt

Dennis Cravens¹, Dennis Letts²

¹ *Amridge University, Cloudcroft, New Mexico*

² *Austin, Texas*

One-hundred sixty seven papers from 1989 to 2007 concerning the generation of heat from electrochemical cells were collected, listed, and digitally posted to a CD for reference, review and study. A review showed four criteria that were required for successful experiments attempting replication of the Fleischmann-Pons effect. All published negative results can be traced to researchers not fulfilling one or more of these criteria. Statistical and Bayesian studies show that observation of the Fleischmann-Pons effect is correlated with the criteria and that the production of “excess heat” is a real physical effect “beyond a reasonable doubt.”

These four enabling criteria include:

- 1) demonstrated care to load Palladium slowly and to assure conditions will provide D/Pd ratios above 0.85
- 2) demonstrated care to respect the chemistry of the system to create favorable surface conditions and materials
- 3) demonstrated care to load at current densities below 25 mA/cm² and then run at current densities above 250 mA/cm² to increase D flux to the cathode, and finally
- 4) demonstrated care to establish non-equilibrium conditions to trigger non-static D positions within the cathode.

Major early “negative papers” were reviewed in light of the enabling criteria and all were found lacking in one or more criteria.



Dennis Cravens

Dennis Cravens is mainly a self funded researcher and has conducted more than 500 electrochemical heat systems since 1989. His current research involves working at high current densities and temperatures, boiling electrolyte systems and explosive testing of deuterated materials. He reminds us to 1) load cold and slow, 2) run hot and hard, 3) and create non-equilibrium conditions for the deuterium.

Dennis Letts is mainly a self funded researcher and has been working on electrochemical heat systems since 1990. He has built over 600 cells to study deuterium in palladium systems. He has pioneered the use of radio frequencies and lasers to trigger events in D-Pd electrochemical cells.

The Dennis Letts and Dennis Cravens team have been collaborating and working together for 16 years in the area of condensed nuclear matter.

Excess Power Gain and Tardive Thermal Power Generation using High Impedance and Codepositional Phusor™ Type LANR Devices

Mitchell Swartz

JET Energy, Inc., Wellesley, MA

Since August 2003, when a low power Pd Phusor™ type LANR device was shown at ICCF10 in an open demonstration for 5 days (producing $\sim >230\%$ excess energy at the multi-watt level while proving optimal operating point operation), we have designed improved Phusor type LANR devices with driving systems which exhibit impressive energy gain and fairly good reproducibility. These include nickel and palladium high electrical impedance [Pd/D₂O/Pt, Pd/D₂O/Au, Ni/H₂O_{1-x},D₂O_x/Pt], and some codepositional DAP- and TAP-Phusor™ type [Pd/Pd(OH)₂/Pt] devices. A few have shown excess power gain of $>800\%$ for short times. Other, more robust, devices have enabled some LANR (lattice assisted nuclear reaction) driven motor engines at the circa 100 watt level, for short times, and lower efficiencies.

What has helped the development continues to be adequate Nyquist sampling, time-integration, thermal ohmic control, thermal waveform reconstruction, and the other techniques to obtain thermal power spectrograms, which have now been supplemented by additional, more precise controls, recognition of causes of failure, faster multiring calorimetry, simultaneous redundant calorimetry, and traceable heat flow measurements. Improved corroboratory measurements now include five or more independent calorimetric or other sensing techniques, each input-power-normalized, to evaluate, and help control excess heat and tardive thermal power (time integral is 'heat after death').

Ultrasonically-Excited Electrolysis Experiments at Energetics Technologies

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The primary objectives of the Energetics Technologies (ET) experimental program are: (1) Improvement of reproducibility of excess heat generation, and (2) Amplification of attainable power and energy gain.

The focus of ET program over the last period is on ultrasonic excitation in electrolysis experiments driven by I. Dardik's modified SuperWaves (SW) [1-3]. The mode of operation presently in use consists of a small number of relatively short ultrasonically induced cavitation cycles accompanying low current density electrochemical loading of the Pd cathode using SW. The cavitation jets impingement onto the surface of Pd cathode is expected to cause the following phenomena:

- Mechano-chemical "cleaning" of the surface resulting in enhanced surface activation.
- Mechanical deformation of the near-surface layer of the Pd target caused by the shock wave generated by impingement of the accelerated deuteron beam. The result is a strong near-surface distortion of the Pd crystalline lattice.
- Massive dislocation and vacancy generation. These defects represent deep deuterium traps in the Pd lattice and increase the Pd cathode deuterium loading capacity.

The net result is that the deuterium loading rate into the Pd is very high and so are the maximum attainable loading level and the reproducibility of excess heat generation. Of the successful set of eleven cathodes experimented with so far, ~80% gave excess heat. Details about the ultrasonically-assisted electrolytic cells will be provided along with the results obtained.

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3. Dardik, I., et al., "Report on Electrolysis Experiments at Energetics Technologies", Proc. ICCF-13, Sochi, Russia, June 25-July 1, 2007



Dr. Shaul Lesin is the general manager of Energetics Technologies, Ltd. – the R&D arm of Energetics Technologies, LLC, since its foundation in 2002. He has a B.Sc. and M.Sc. degrees in Mechanical Engineering and a Ph.D. in Chemical Engineering, all from Ben-Gurion University of Israel. He has over thirty years of experience in the R&D and management of a wide-range of emerging technologies. He is the author of over 50 technical papers and inventor of 10 patents, granted and pending.

A simple calorimetric method to avoid artifact in a controversial field: the ice calorimeter

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The idea of the ice calorimeter is rather old. Antoine Lavoisier (1743-1794) developed in 1783 a calorimetric method based on the measurement of the mass of the ice that melts when heated. It is thus an absolute measurement, only based on the determination of a mass, the amount of heat released being then computed from the very well known physical properties of ultra pure water.

This concept has been implemented, using modern technology to accurately measure the amount of ice that melts during an experiment. The calorimeter can accommodate a cylindrical reactor (diameter 36 mm, length 200 mm). Energies up to 15000 J can be measured, with an absolute precision better than 2%.

A description of the calorimeter will be given, together with examples of measurements.



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1958 Diploma from «Ecole Nationale Supérieure des Mines de Paris»

1963 Penarroya mining company

1964 Shell group of companies. Various positions in refineries, head quarters, commercial organization and research (in France and in the Netherlands).

1988 Director of scientific relations for Shell group in France.

1993 Project leader in "Laboratoire des Sciences Nucléaires" (CNAM). - Anomalous heat effects in certain metal/hydrogen systems -

Constant Heat Flow Calorimeter

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A constant heat flow calorimeter is described and its application to a Fleischmann-Pons experiment is detailed. In this calorimeter the electrolytic cell is contained in an isothermal chamber into which electrical power is fed from two separate sources. One source feeds biasing power $P_{aux.}$ to an auxiliary resistive element located in the chamber while the other source provides, P_e , the electrochemical power requirements for the cell. The cell temperature T_1 is maintained at its set point by varying $P_{aux.}$ as needed. Clearly power needs to be removed from the cell if a steady state is to be maintained and this is accomplished by inducing heat flow through a thermal link to a reference body whose temperature T_2 is less than T_1 . The heat flow is a function of the thermal gradient which needs to be closely controlled which in turn requires active control of T_2 and this is accomplished by coupling the reference body to an external heat reservoir through a Peltier element. Power to the Peltier element is varied to maintain the temperature of the reference body at T_2 . Heat stored in the cell requires an increase in $P_{aux.}$ to the cell while heat generated in the cell results in a decrease in $P_{aux.}$ to the cell. The details of the operation of the system over a period of 40 days is presented along with evidence for heat production.

Mass Flow Calorimetry

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Discussion of the Mass Flow first principles calorimeter in this paper is based primarily on the analysis and experience gained at SRI in answering the question: “is there a Fleischmann Pons heat effect (FPE)”? Subsequently other mass flow calorimeters, or more generically heat balance calorimeters, were designed to answer this same question and some comment will be directed to the technical differences resulting from different design philosophies, specifically those designed and operated at ENEA, Osaka University, Energetics and the University of Tomsk.

In 1989 the challenges to the second-generation FPE calorimeters were threefold:

- i. To allow reproducible demonstration of the effect – whether it be real or the consequence of (unidentified) systematic error,
- ii. To exhibit proven levels of accuracy, over sufficient periods to quantify heat generation consistent with the FPE,
- iii. The operating principle must be sufficiently simple to allow an open-minded non-specialist to visualize the full range of potential error.

Discussion will be undertaken of ideal and non-ideal calorimeter operation, design principles and practical implementation including long and short term accuracy and sensitivity as well as limitations of heat balance calorimeters as the vehicle chosen to study the FPE.



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Dr. McKubre is an expert in the areas of PdH and PdD electrochemistry and calorimetry and has directed research and undertaken consulting in this area for EPRI, MITI, DARPA, DTRA, NRL, ONR, ENEA

ICCF 13. Credit E. Alvarez.

Isoperibolic Calorimetric Measurements of the Fleischmann-Pons Effect

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Important advantages exist for selecting a Dewar type isoperibolic calorimeter for measurements of anomalous excess enthalpy produced by the Fleischmann-Pons Effect (FPE). These advantages include a wide dynamic range for both the cell temperature and cell input power, relative low cost, self-purification of the system, the safety of an open system, and heat transfer mainly by electromagnetic radiation. Various generations of this calorimetry are described along with the mathematical modeling. The use of control or “blank” experiments, such as replacing palladium by platinum, show that anomalous excess power is measurable to within ± 0.1 mW using this electrochemical calorimetry. The application of this Dewar isoperibolic calorimetry at other laboratories such as NHE (Japan), Grenoble (France), and Harwell (U.K.) is discussed. Variations of isoperibolic calorimetry used by China Lake, Caltech, and M.I.T. are also examined where the main heat transfer pathway is by conduction. An improved version of the China Lake isoperibolic calorimeter is capable of measuring the small excess power (5 mW) produced at the beginning of an experiment by the exothermic absorption of deuterium into palladium.



Dr. Melvin H. Miles received his B.A. from Brigham Young University and his Ph.D. in Physical Chemistry with a minor in Physics from the University of Utah in 1966. His Ph.D. thesis was on fast reaction kinetics. His career includes 28 years as a research scientist for the Navy laboratories at Corona and China Lake, California where his research involved fuel cells, batteries, electrochromic materials, corrosion, supercapacitors, thermodynamics, carbon dioxide reduction, and cold fusion. Dr. Miles also worked on cold fusion for six months in 1997-1998 at the NHE laboratory in Sapporo, Japan. He is presently working on lithium thermal batteries as a contractor for the Navy as well as on cold fusion research.

The Method and Results Using Seebeck Calorimetry

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Acceptance of the Pons-Fleischmann effect has depended on acceptance of anomalous heat production. Proving this claim involves use of a calorimeter. At least five different basic kinds have been used. Naturally, each design has its own set of errors and characteristics needing evaluation. Besides having only a small error, a calorimeter used to study cold fusion also must be very stable because the studies usually last for a long time. In addition, the heat generated by the electrolytic process needs to be removed to avoid having the cell get too hot. Because this background energy can be large and the anomalous energy can be small, the calorimeter needs to be very sensitive over a wide range of heating power. No single design is ideal in meeting these requirements. Nevertheless, the Seebeck- or Kelvin- type comes close. This type of calorimeter measures power. Accurate values can only be obtained when the temperature within the calorimeter is constant. Energy of a reaction is obtained by integrating the power over a period of time. This paper will describe the construction, operation, evaluation, and some results obtained using such a calorimeter. Other authors have also used and described the method.

On the Correlation of PdD Alloy Material Properties with the Occurrence of Excess Power

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A recent joint work [1] identified the crucial role of material science to improve control of the Pd-D system in order to study the production of excess power during electrochemical loading of palladium foils with deuterium. The very high reproducibility (close to 100%) in loading Pd up to D/Pd ~1 (atom. frac.), considered to be the threshold to observe excess power, confirmed that the condition D/Pd ~1 is necessary, but not sufficient, for observation of the excess power effect.

Now, as a consequence, the focus has shifted to the study of surface and bulk properties of the palladium foils employed in calorimetric experiments, to correlate the appearance of excess power with material properties.

A description of palladium foil properties found to be associated with excess power will be presented.

[1] V. Violante, et al. Calorimetric Results of ENEA Cooperative Experiments. Proceed. XIII Int. Conference On Cold Fusion, Sochi (Ru) June 2007 (in press).

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Investigations of Nanoparticle Palladium/Deuterium Systems in Zeolites

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Both experimental and theoretical studies have indicated that nanoparticle palladium may facilitate the Fleischmann-Pons Effect (FPE). The possibilities of producing excess energy, in the form of heat, were investigated by observing palladium-loaded zeolite-Y under a deuterium atmosphere. This method involved loading the zeolite with an organo-palladium complex and then burning off the organic constituents of the compound in order to leave empirically pure palladium within the zeolite cavities. The presence of palladium in the zeolite was confirmed by analysis using an electron microscope and by energy dispersive X-ray spectroscopy. Preliminary results showed that after the deuterium gas flow was stopped, the temperature of the nanoparticle palladium system increased to several degrees above the room temperature. This effect was observed during two runs under deuterium gas. A third control experiment run under hydrogen gas did not show this unusual rise in temperature. Further experiments are being conducted. The Zeolite-Y (Na) used in these studies has small pores with a relatively strong electrostatic charge (0.3 V/\AA) and may act as a quasi-nano reactor.



Dr. Iraj Parchamazad is Chairman of the Chemistry Department at the University of LaVerne. He was a Visiting Professor, Chemistry Department, University of Texas at Austin as well as a Visiting Scientist at the University of Brunel, England, at University Aix-Marseille, France and at M.I.T. Dr. Parchamazad has many scientific papers in the field of physical organic chemistry and several patents (granted or pending) in the field of fuel cell technology. His research interest include electron-transfer process involving Twisted Intramolecular Charge Transfer states (TICT), alternative energy, hydrogen reforming, and photochemical storage of solar energy. Another research interest is the use of zeolites as nano-reactors for studying chemical reactions within zeolite cages.

Study of the Nanostructured Palladium Hydride System

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Electrochemical deposition of metals from hexagonal lyotropic liquid crystalline phases produces metal films with a unique ordered nanostructure in which the cylindrical pores of 1.7 to 3.5 nm running through the film are arranged in hexagonal arrays[1,2]. Nanostructured Pd films were deposited electrochemically from the template mixture of either C₁₆EO₈ or Brij56. Electrochemical studies showed that the metal films have a high electroactive surface area with the specific surface area of the order of 91 m²/g. These values together with the TEM and X-ray data are consistent with the expected H₁ nanostructure[3].

The hydrogen region of nanostructured Pd in the cyclic voltammetry in 1 M H₂SO₄ was more resolved than that of plain Pd because of the thin walls of the nanostructure and the high surface area. We could distinguish the hydrogen adsorption and absorption processes. The permeation of hydrogen into the Pd metal lattice occurs with fast kinetics when the Pd surface is blocked by either crystal violet or Pt. We believe that the hydrogen absorption process takes place without passing through the adsorbed state so that hydrogen diffuses directly into the Pd bulk. This process speeds up when the formation of adsorbed hydrogen is suppressed by the coverage of poisons[4]. These results were compared to those obtained in a heavy water solution to which the Pd electrode was exposed. Adsorption characteristics of deuterium on the Pd metal surface are slightly different to those obtained for hydrogen in previous studies. Diffusion of deuterium into the Pd metal lattice works with fast kinetics under appropriate surface modification.

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Basic research on condensed matter nuclear reaction using Pd powders charged with high density deuterium

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It has been recently reported in ref. [1] that charging of highly pure D₂ gas into Pd nano-powders in the form of Pd/ZrO₂ nano-composite contained in a stainless-steel vacuum vessel has induced significant difference in inside- and outside-temperatures, while that for blank run using H₂ gas showed nearly zero difference. The temperature difference lasted for more than 50 hours. To verify that the excess heat originates in nuclear reaction, QMAS was employed to show the existence of ⁴He as nuclear ash in the vessel. It has been shown in the demonstration experiments that the phenomenon seemed to be highly reproducible as far as the same equipment was used.

In the present work we have constructed an experimental system to replicate the phenomenon of heat and ⁴He generation and investigate the underlying physics.

The system is composed of two identical chambers (twin system); one for D₂ gas foreground run and the other for H₂ gas blank run. Each system has inner reaction chamber containing Pd powders and we evacuate the outer chamber for thermal insulation. In addition to the thermocouples setup in sample Pd powder and outer surface of the reaction chamber for temperature measurement, a cooling system is provided for flow calorimetry to estimate heat production rate.

[1] Y. Arata, et al.; The special report on research project for creation of new energy, J. High Temperature Society, No. 1. 2008.



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Cold Fusion by Gas Loading: A review

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The original Fleischman and Pons experiment was electrochemical. The main reason was that it was a lot simpler than other methods and easy to develop. However there are obvious limits in using water based technologies. One of them being that at atmospheric pressure water boils at 100°C, and for electricity generation applications, this is too low a temperature. Obviously by operating at high pressures, higher temperatures can be reached, but this is a complex technology. A solution is the use of gases that permit a wide range of operating conditions: pressure and temperature. Another advantage of using gases is that it is a much cleaner system than electrochemistry.

A number of scientists have worked in this direction, and the results are very promising. In this review we will analyze the various methods used and the results obtained. These methods have demonstrated production of heat, helium, and transmutation. Experiments have been performed using deuterium gas with palladium, but also hydrogen gas with nickel.

Deuteron Electromigration in Thin Pd Wires Coated With Nano-Particles: Evidence for Ultra-Fast Deuterium Loading and Anomalous, Large Thermal Effects

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A new procedure has been developed at Frascati National Laboratories of Istituto Nazionale di Fisica Nucleare for the production and detection of anomalous thermal effects on long (50-150 cm) and thin (50 μm) Pd wires. The wires surface was previously coated with a complex mixture of salts and nanomaterials, capable to produce, after high temperatures heating in air, a thin layer of nanometric materials. The wires, put in a stainless steel chamber pressurised with Deuterium gas, were Joule heated by a dc current ($J=5000-50000 \text{ A/cm}^2$); the combined effect of high electric field and high temperature caused a large deuterons electromigration in the wires.

After applying D_2 pressure of 5 bar the following has been observed:

- a. Extremely short loading time (6-12s) to achieve the R/Ro value of 2 at temperatures (from 23°C) peaked to 45°C, for few seconds, during Deuterium intake. The steady state D/Pd ratio was about 0.8 at 23°C;
- b. Anomalous thermal effects when large electromigration current was applied.

In our experimental set-up, at the moment, an isoperibolic calorimeter is used for the assessment of possible anomalous thermal effects because fast response time (about 1500s) and simplicity. Such anomalous effects seem to be related to a trigger temperature of about 120°C and tend to increase in magnitude by increasing wire temperature. Up to now, with a Pd wire of 14mg of weight, an anomalous power of over 3W at about 300°C was detected: such value is equivalent to a power density of over 200W/g of Pd.

The anomalous thermal effects are proportional to the intensity of the current flowing along the wire and increase with the increasing of the current density.

In Honor of Yoshiaki Arata

Talbot A. Chubb

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This presentation honors Yokiashi Arata and the pioneering work which he has carried out in conjunction with Yue-Chang Zhang. The A-Z team have defined what is meant by nanoPd fusion, have proved that nuclear reactions can be made to take place in nanometer solid material, and have opened the road to development of commercial fusion heaters.

Dr. Arata is Professor Emeritus at Osaka University. Born in 1923, he graduated from Osaka U. with a Bachelors in Engineering in 1949, a Doctorate in 1957, and became Professor. in 1964 . He started Japan's plasma fusion program. Since there was no D₂ gas available for his arc plasma studies, he made his own gas by plating D₂O electrolyte onto a Pd cylinder. In 1958 he achieved the world's record for arc discharge current density. He was a pioneer in electron beam and laser beam welding and became Director General of the Osaka U. Welding Institute in 1977. Arata was elected Member of the Japan Academy in 1988, received the Arthur Schawlow Prize in 1992 (American Society of Metals), and was honored by the Emperor of Japan in 1995 and 2006. He has received many other awards.

Professor Yoshiaki Arata started his cold fusion studies in 1989. Forming a team with Yue-Chang Zhang, A-Z developed a method in which they deposited Pd-filtered deuterium onto a nanoPd catalyst bed inside a Pd-walled vessel, called a DS-Cathode. Their experiments produced fusion heat with unprecedented repeatability. They used water flow calorimetry in which water flow was controlled by a constant displacement liquid pump and inflow temperature was stabilized by constant temperature bath. Cell voltage and current were digitized. Calorimetric stability was checked by equality of inflow power and output power during an initial "incubation" portion of run time. In their 1994 study they used the high surface mobility of Pd-black and its ability to redistribute and absorb inflowing deuterium at below pressure gage sensitivity to identify suitable catalyst.

Study A-Z (2002) showed the superiority of ZrO₂ + nanoPd catalyst over Pd-black. They recorded 10 W of heat throughout a 3-week period. Study A-Z (2005) showed that fusion heat could be produced without electrolysis at 190°C using gas loading. Study A-Z (2008) showed that fusion heat could be produced and maintained at room temperature with zero heater and zero electrolysis energy input. Since no source of sustained heat generation other than nuclear reaction has been identified, A-Z (2008) provides unique evidence for cold fusion reality. A description of experiment history and past results is provided as a background for Arata's discussion of the latest A-Z results.

[1] Y. Arata and Y-C Zhang, *Proc. Japan Acad.* **70B**, 106-111 (1994); *ibid.*, *Proc. Japan Acad.*, **78B**, 57-64, (2002); *ibid.*, Y. Arata and Y-C Zhang, *Proc. ICCF 12*, 44-54 (2007) [oral presentation in 2005]; *ibid.*, *J. High Temp. Soc. Jpn.* **34**, 83 (2008).

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“Solid Fusion” Reactor with Zero Input Energy

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Prof. Yoshiaki Arata plans to present the latest Arata and Zhang results using catalyst containing nanoPd.

Yoshiaki Arata, Professor Emeritus, Osaka University and Member of Japan Academy.

LENR Research using Co-Deposition

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In 1989, Dr. Stanislaw Szpak devised a means of initiating the Fleischmann-Pons effect that greatly reduces the incubation time and gives reproducible results. In this process, referred to as Pd/D co-deposition, working and counter electrodes are immersed in a solution of palladium chloride and lithium chloride in deuterated water. Palladium is then electrochemically reduced onto the surface of the working electrode in the presence of evolving deuterium gas. SEM analysis of electrodes prepared by Pd/D co-deposition exhibit highly expanded surfaces consisting of small spherical nodules. Cyclic voltammetry and galvanostatic pulsing experiments indicate that, by using the co-deposition technique, a high degree of deuterium loading (with an atomic ratio $D/Pd > 1$) is obtained within seconds. These experiments also indicate the existence of a D_2^+ species within the Pd lattice. Because an ever expanding electrode surface is created, non-steady state conditions are assured, the cell geometry is simplified because there is no longer a need for a uniform current distribution on the cathode, and long charging times are eliminated. Using a Dewar-type electrochemical cell/calorimeter, it was shown that the rates of excess enthalpy generation using electrodes prepared by the Pd/D co-deposition technique were higher than that obtained when Pd bulk electrodes were used. Positive feedback and heat-after-death effects were also observed with the Pd/D co-deposited electrodes. Infrared imaging of electrodes prepared by Pd/D co-deposition show that the working electrode is hotter than the solution indicating that the heat source is the Pd/D co-deposited electrode and not Joule heating. The infrared images also show that the heat generation is not continuous, but occurs in discrete spots on the electrode. The 'hot spots' observed in the infrared imaging experiments suggest that 'mini-explosions' were occurring. These 'mini-explosions' were confirmed by conducting the Pd/D co-deposition directly on a piezoelectric transducer. To verify that the heat produced by Pd/D co-deposition was nuclear in origin, experiments were conducted to detect the nuclear ash. Using the Pd/D co-deposition, the following nuclear emanations have been detected: X-ray emission, tritium production, transmutation, and particle emission.

Charged Particle Emission during Electron Beam Excitation of Deuterium Subsystem in Pd and Ti- Deuteride Targets

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Recently, it was shown theoretically that excitation of the deuterium/hydrogen subsystem in Pd and Ti deuterides with ionizing radiation is caused a strong electric field generation in metal-deuterium system resulting in proton/deuteron acceleration inside the lattice from kT values to the range of several eV [1,2]. Taking into account that electron or X-ray beam excitation can also to enhance the diffusion rate in the deuteride sample, it was expected that strong DD-reaction cross-section enhancement would be obtained for those e-beam irradiated Pd and Ti deuterides. This will allow to generate measurable yields of DD-reaction products (and possibly other energetic species) due to high screening potentials of the metal deuterides with a high Deuterium diffusivity [3].

In order to verify this hypothesis on the role of excitation of the hydrogen subsystem in metal deuterides (Pd/PdO:D_x and TiD_x) to enhance the yield of low energy nuclear reactions (LENR), we have carried out a series of experiments on charged particle detection using electron-beam (in vacuum) stimulation of various metal deuterides during spontaneous deuterium desorption from the deuterium loaded samples. In order to identify the type and energy of emitted particles, we used simultaneously two or three CR-39 detectors covered with various foils with known stopping ranges. The Foreground counts have been read out from the CR-39 surface of detectors faced to the sample, while the Background counts have been taken from the rare sides of these same detectors faced to the vacuum chamber or to the stainless support.

Experiments showed that the electron beam (J ~ 100-300 nA, E = 30 keV) stimulation of the surface in Pd and Ti deuteride targets (cathodes) is resulted in enhancing the intensity of the nuclear emissions of charged particles. Both products of DD-reaction (3 MeV protons) and high energy alphas are clear distinguished in e-beam stimulation experiment with the Pd/PdO:D_x and TiD_x targets. It is important that signatures of 3 MeV and energetic alphas are appeared simultaneously at the surface of all (2 or 3) independent detectors used in the same experiment and provided by metallic foil filters with different stopping ranges/powers.

The details of the experiment as well as possible mechanisms will be discussed.

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Detection of Radiation Emitted from LENR

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A study was made to detect X-radiation and energetic particle emission from nuclear reactions that are initiated during low voltage gas discharge in deuterium. Evidence is presented for X-radiation and energetic particle emission.

A study of radiation emitted from materials exposed to deuterium gas is underway. The method will be described in addition to any anomalous results that are observed.

Reproducible Evidence for the Generation of Nuclear Particles During Electrolysis

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Past work in this laboratory has shown that nuclear particles generated during electrolysis can be registered by CR39 plastic detectors held within the electrolyte solution, suspended in the vapor above the solution, or placed just below the metal cathode plate that serves as the bottom of the electrolyte compartment of the electrolysis cell. However, not every electrolysis experiment produced nuclear particles so that total reproducibility was not achieved. Therefore another experimental technique has been developed which has shown the generation of nuclear particles in each of twenty five consecutive electrolysis experiments using heavy or light water solutions of lithium sulfate. The damage trails caused by the nuclear particles are made visible by etching in hot concentrated caustic solution and the electrolysis experiments are accompanied by suitable control or blank experiments. The damage trails begin either at the surface of the CR39 chip that faces toward the electrolyte, at the opposite surface, or totally within the 0.83 mm thickness of the plastic detectors. It is demonstrated that the nuclear damage trails could not have been caused by the decay of ordinary radionuclides contaminating anything involved in the experimental procedure. The described phenomena pose a formidable challenge to theorists attempting to develop a mechanistic understanding to LENR.

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The Importance of Replication

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A considerable and enduring criticism of the research field of the Fleischmann Pons Effect (FPE) comes from our inability to demonstrate the effect on demand, to reproduce the magnitude and timing of the effect, or in every case to transport and transplant a successful experiment from one laboratory to another. The continuance of this debate has hampered scientific acceptance of the effect by discouraging funding, thus impeding technical progress. The fact that critical variables are either not understood or not under control has delayed the attainment of a comprehensive phenomenological understanding of the effect. SRI in close cooperation with ENEA has mounted a campaign on two fronts with the intent of overcoming legitimate criticisms of apparent irreproducibility. Our joint purpose is to:

1. Achieve empirical understanding of all variables critical to the attainment and maintenance of the FPE.
2. Work to reproduce experiments at SRI initially performed independently by others.

Important achievements of both parts of this strategy will be reported and highlighted by examples. The significance of the present state of reproducibility of the FPE will be discussed with contextual reference to the scientific “reality” of the FPE and the steps needed to advance the effect from science to technology. One important step on the path forward is the development of a comprehensive theoretical model that is quantitatively predictive. This will supplant the empirical understandings that have so far allowed us to explain our failures but not to predict the quantity and timing of FPE heat excesses.



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ICCF 13. Credit E. Alvarez.

Development of New Detector System for Charged Particle Emission

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Charged particle detection is most sensitive method to verify condensed matter nuclear reactions. A CR-39 track detector has been frequently used for electrolysis and desorption experiments[1-3]. However, the detector cannot give a time profile of the reaction rate, and it is difficult to get good energy calibration as well as particle identification. Furthermore, background events caused by cosmic rays and natural radio isotopes cannot be easily suppressed. In order to overcome the disadvantages, we have developed a new detector system suitable for gas permeation experiment.

An experimental setup is a similar one originally reported by the Mitsubishi Heavy Industry group for selective nuclear transmutation from Cs to Pr[4]. Although the mechanism of the transmutation has been unknown, we expect any kind of charged particle emissions spilled out through the transmutation process. In this case, we cannot use a Si semiconductor detector which is deteriorated in hydrogen atmosphere and loses its resolution, because nuclear reactions are expected to observe at the D₂ side not at the vacuum side.

We have examined various scintillation detectors and found that Cerium doped Yttrium Aluminum Perovskite (YAlO₃ : YAP(Ce)) is the best for the present purpose because of its good chemical stability and little dependence of light yield on the temperature. Finally, we made a scintillator phoswich consisting of the YAP(Ce) and a plastic scintillator (BC444), where lights emitted in both scintillators are detected with the same photomultiplier tube. Using a difference of electrical pulse shape, one may discriminate a light emitted in the YAP(Ce) from that in the BC444. Hence, the phoswich can serve for particle identification and to decrease background events. Furthermore, in order to reduce background events more, a permeation chamber in which the phoswich detector is placed is surrounded by plastic detectors serving for vetoing cosmic rays. We applied pulse shape discrimination (PSD) technique to identify very rare events. All pulse shapes from the photomultiplier tube were recorded by a digital storage oscilloscope for off-line analyses after the experiment. Consequently, this system can identify very low reaction rate events (3 counts / day) for a several-MeV range.

By using this new detector system, we examined several samples and tried to observe high energy charged particle events during D₂ gas permeation. The measurements were carried out under D₂ gas permeation. Background events were measured with the same apparatus but with H₂ gas permeation as well as vacuum conditions. In the presentation, we will report on our detection system in detail, and discuss on the results of the permeation, especially for energy spectra at a higher energy region.

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Considerations for Ultra-Trace Analysis of Metals in a Palladium Matrix

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Changes in isotopic abundances or production of radioactivity are the best signatures of a LENR. However, the amount of unique elements produced should be low (< micrograms) unless the heat output of the LENR is very large. Thus, claims that have been made for transmutation reactions or the production of new elements not present in the original matrix or apparatus should be carefully considered unless extreme care was taken to control sources of contamination in the whole procedure - from production of raw materials to assembly of the apparatus to final analysis. Surface and bulk impurities also may play a role in the production of excess heat in a palladium matrix when exposed to deuterium and their detection and control need investigation. Considering how the raw materials are manufactured and sampled may cause variations within a given lot that is not reflected on the certificate of analysis from the manufacturer. These within lot variations may be one source or irreproducibility in LENR experiments. Trace analysis of bulk material can be very useful for quality control. For example, we found that the supplier of palladium sheet had changed their production procedure and predicted what production change had occurred from a change in the trace impurity profile in the stock material.

Determining what is present before and after a given procedure requires trace analysis. However, many researchers are unfamiliar with the handling requirements for trace analysis, especially the ease at which a surface becomes contaminated from the ambient environment. This presentation will discuss methods for controlling and detecting contamination, method for the analysis of trace metals in bulk palladium matrix and on the surface, pitfalls in the interpretation of ICP-MS and SIMS data, and some precautions necessary to provide evidence of a LENR. Examples from the LENR literature will be highlighted that show contamination or unfamiliarity with the quirks of certain techniques may have misled previous researchers in some of their claims.



Dr. David A. Kidwell is a research scientist in the Surface Nanoscience and Sensor Technology Section of the Chemistry Division at the Naval Research Laboratory for the past 24 years. He received his B.S. degree from the University of North Carolina at Greensboro and his PhD from MIT in organic chemistry with an emphasis on instrumentation. Dr. Kidwell has extensive experience in immunoassays, DNA assays, computer programming, electronic design, and mass spectrometric instrumentation. He is an active researcher in a number of sensor-related fields, with emphasis on trace detection. He has published 38 refereed papers and has received 13 U.S. patents. For the past three years he has worked on characterizing impurities in palladium and trace metal contamination in the environment by ICP-MS.

Transmutation Reactions Induced By D₂ Gas Permeation through Pd Complexes (Pd/CaO/Pd)

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We have been studying low energy nuclear transmutation reactions induced by D₂ gas permeation through Pd multilayer complexes. Transmutation reactions of Cs into Pr, Ba into Sm and Sr into Mo were observed. Especially, transmutation of Cs into Pr has been confirmed by “in-situ” measurement using x-ray fluorescence spectrometry (XRF) at SPring-8. Up to now, we reported that transmutation reactions seem to occur at localized spot near surface within 100nm under our experimental conditions.

In this conference, we present recent progress of our research. Identification for an unidentified peak that appears during transmutation experiments of Cs into Pr at SPring-8 by changing x-ray excitation energy will be presented. Ti was detected by the method and La was also detected in some cases during D₂ permeation experiments. Discussion on the origin of Ti and La will be presented.

Investigation of Nuclear Transmutation Using Multilayered CaO/X/Pd Samples Under Deuterium Permeation

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It was claimed that the forced permeation of deuterium through Cs(Sr)-deposited multilayered Pd/(CaO/Pd)₅ samples did induce nuclear transmutations from ¹³³Cs(⁸⁸Sr) to ¹⁴¹Pr(⁹⁶Mo) [1]. To confirm the nuclear transmutation and to study the mechanism, we constructed an experimental system, with which accelerator analyses by PIXE, ERDA, NRA and RBS can be made in situ under deuterium gas permeation through the samples.

In our previous work [2], we used XPS to characterize the CaO/Sr/Pd sample. The XPS method has high sensitivity of detection limit 7×10^{12} atoms/cm² applicable only for the near-surface (< 3 nm) region, and is necessarily destructive when measurement of the depth distribution over tens of nm is required. Therefore we have used PIXE to measure nondestructively the time-dependent concentration of the elements in the sample in situ at the cost of increasing the sensitivity limit to 1×10^{14} atoms/cm².

From the practical point of view, it is important to increase the number of atoms to transmute. Since the transmutation seems to take place either at the boundary layers or on the surface facing to vacuum, we have made multilayered (CaO/X/Pd)_n samples by alternative deposition of the material on a Pd substrate sheet with a thickness of 0.1 mm; CaO and Pd layers with a thickness of 2 - 8 nm and 18 - 54 nm, respectively, made by sputtering deposition. Sr or Cs was chosen as "X", that is the sample atom to transmute, by electrochemical deposition. To examine the surface effect, any one of CaO, X or Pd layer is to be tested as the top layer of the sample. The films are mounted on a vacuum flange with O-ring seal and the rear surfaces are exposed to D₂ gas at a pressure of 0.1 MPa.

Although no results offered clear evidence of the transmutation up to now, the ERDA has been successfully applied to reveal the deuterium density approaching the saturation value in some samples.

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Influence of Deuterium Gas Permeation on Surface Elemental Change of Ion-Implanted Pd

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Nuclear transmutation with deuterium gas permeation through Pd/CaO multilayer system has firstly been reported by Iwamura et al. [1]. By using X-ray photoelectron spectroscopy (XPS), they have demonstrated that Sr and Cs deposited on top of the multilayer system convert to Mo and Pr, respectively, with D₂ gas permeation for a period of one week or so at a temperature as low as 343 K. The isotopic ratio for Mo has been shown quite different from the natural one with secondary ion mass spectrometry (SIMS). By using the D₂ gas permeation method, they have further found that Ba converts to Sm [2].

These results are considered easy to replicate in different laboratories. However, only a limited number of replication experiments have been reported so far [3-5]. One of the difficulties in replicating the Iwamura group's experiments may be the high D₂ gas flow rate they have used in their experiments [6]. Hydrogen gas flow rate through Pd is sensitive to the state of surface. Therefore, appropriate pretreatments of Pd as well as a clean experimental environment are required to obtain a high D₂ flow rate. We have reported that commercially available Pd foils are often contaminated with S [6] and the S impurity segregates on the surface during D₂ gas permeation. If S is on the surface, it is difficult to examine the generation of Mo by using XPS, because S_{2s} XPS peak overlaps with Mo_{3d} peaks.

In this study, pure Pd foils were implanted with 65 keV Sr⁺ ions, and these foils were subjected to D₂ gas permeation treatments at 343 K. XPS was used to examine the surface elements before and after D₂ gas permeation. For the sample before D₂ gas permeation, almost no Mo or S was observed. For the sample just after D₂ gas permeation, strong peaks of S_{2s} were observed, suggesting the surface segregation of S caused by D₂ gas permeation. In order to remove S on the surface, the sample was subsequently annealed in air at 1273 K for 10 min. After this treatment, XPS peaks for S_{2s} almost disappeared and the peaks of Mo_{3d} clearly appeared. However, a TOF-SIMS analysis for the sample showed that the isotopic ratio for Mo was similar to the natural one. The results for Cs ion implanted Pd will also be presented.

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Elemental Mapping on the Surfaces of Palladium Cathodes after Electrolysis

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Our previous studies, using a scanning electron microscope (SEM) equipped with an energy dispersive spectrometer (EDS), have shown that, in addition to excess heat, unexpected elements occur on the surfaces of cathodes after electrolysis in an acidic electrolyte containing heavy water [1, 2]. This was true for both Pd and Ti cathodes. Using a secondary ion mass spectrometer (SIMS), it was found that there were changes in isotopic abundance on the surfaces of Pd cathodes after electrolysis [3]. These changes generally diminished with increasing sputtering time, suggesting that the changes occurred in the outermost layer to a depth of about 1 μm . Changes in Ti isotopic abundance were also found using an inductively coupled plasma mass spectrometer (ICPMS) after electrolysis with Ti cathodes [4]. Gamma ray spectrometry revealed that there were changes in isotopic abundance of U after glow discharge with U cathodes in a plasma of either H or D [5], and similar results were obtained after electrolysis with U cathodes in an electrolyte containing $\text{H}_2\text{O}/\text{H}_2\text{SO}_4$ [6].

More recently we reported that adding Ti to the $\text{D}_2\text{O}/\text{H}_2\text{SO}_4$ electrolyte resulted in enhanced excess heat production [7]. Recent SEM images of Pd cathode surfaces after electrolysis revealed that nanotubes were present, and EDS spectra revealed that the nanotubes are composed mainly of Ti and O. The nanotubes apparently grow out from the cathodes during electrolysis. TiO_2 has well known catalytic properties [8]. A possibility is that it has catalytic properties in the production of excess heat.

Elemental mapping was used to show the surface distribution of the elements which were detected with the EDS. These include C, O, S, Si, Ti, Pd, and Pt. Ag was also found, in random spots about 1 μm diameter.

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“Condensed Matter Nuclear Science” Research in China

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This article about the history of “Condensed Matter Nuclear Science” research in China follows an outline suggested by Prof. M. Melich at the Catania Workshop in 2007. It starts with the nomenclature of “cold fusion”; then, five features of “Condensed Matter Nuclear Science” research in China are addressed. They are:

- (1) National policy has been to continue the research in the hope that an original breakthrough will be made.
- (2) Top scientists with high reputations continue to back up this research.
- (3) International exchanges are of a supportive nature for this research in China.
- (4) Chinese scientists have attempted to develop their own approaches, with their own inventions.
- (5) Some hot fusion scientists in China have an open mind toward cold fusion research.

As a result we still have a group of researchers working on this subject ranging from young Ph.D. candidates to old retired professors.

Five important meetings are described from the beginning to April of 2008. These five meetings expressed the national willingness to overcome all those obstacles, although the controversial nature of this research continues to make it difficult to develop this research. These meetings are sponsored by The Ministry of Science and Technology of China, The Natural Science Foundation of China, and The China Association for Science and Technology.

Twenty institutions are listed with their principle investigators, research stuffs, and main research subjects. They are under The Chinese Academy of Science, The China Institute of Atomic Energy, The Chinese Academy of Engineering Physics, The Ministry of Nuclear Industry, and The Ministry of Education. In addition to the table, 29 papers are cited to show their contributions from each institution, and the milestones of their development. Certain researchers are mentioned by name, with their contributions, such as proposal of the helium detection, the use of nano-meter material, etc. Almost all the experiments and concepts in the world may have their counter-parts in China. From excess heat study to nuclear transmutation detection; from the electrolytic cell to gas-loading chamber; from “high pressure-low temperature” to “high temperature-low pressure”; from the glow discharge tube to the search of evidence of natural fusion; from heavy water to light water electrolysis; from laser triggering to the effect of magnetic field; from isoperibolic calorimeter to Seebeck calorimeter; from micro-hot-fusion to statistical energy concentration; and from “poly-neutron” to “organic water”, “hydrino-like atom” and Beruit’s ion-orbital state, and from electron screening effect to selective resonant tunneling.

The article includes three photos; two of them are published for the first time.

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Cold Fusion in France

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Following the public announcement of the discovery of Cold Fusion in 1989 by Martin Fleischman and Stan Pons, several laboratories in France started experimental works on Cold Fusion. There were both an official program organized by the CNRS (Centre National de la Recherche Scientifique) and the IN2P3 (Institut National de Physique Nucléaire et de Physique des Particules) to detect production of neutrons during electrolysis of heavy water, and several individual experiments performed in various laboratories.

The CNRS-IN2P3 team did not detect any neutron, even though they used the best available neutron detector, and collaborated with well-known electrochemists. This was the end of the official support of Cold Fusion in France. In parallel several individuals in private industry Jacques Dufour at Shell and several others at the Commissariat à l'Énergie Atomique in Grenoble (Georges Lonchamp), in Cadarache (Francis Forrat), started their own experiments with the original protocol or with their own.

In parallel, Jean-Pierre Vigier, editor of Physics Letters A, a well known theoretician in France accepted publication of papers related to Cold Fusion.

Since the early start, a number of institutions have developed Cold Fusion for some time. The CEA in Grenoble had an official program for three years 1997-1999. Similarly Electricité de France (EDF) had for a couple of years a research program in the field. Later IMRA in Sophia Antipolis with Stan Pons and Martin Fleischmann started a major research project.

At the moment there are only two institutions working in Low Energy Nuclear Reactions: the CNAM (Centre National des Arts et Métiers) in Paris with Jacques Dufour and Pierre Clauzon, and the University of Marseilles with Jean Paul Biberian.

History of Cold Fusion Research in India

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The main centre where cold fusion related studies was carried out in India was the Bhabha Atomic Research Centre (BARC), Mumbai although a few individuals from other research centres such as the Tata Institute of Fundamental Research at Mumbai and the Indira Gandhi Centre for Atomic Research in Kalpakkam also entered the fray. Scientists at BARC got involved almost from day one after seeing a small four line news item in the Times of India newspaper on 25th March 1989. Much credit for the early start goes to Dr. P. K. Iyengar the then Director of BARC who immediately convened a meeting of persons likely to be interested in the topic from various divisions of BARC. His encouragement and enthusiasm was most contagious. Within a couple of weeks almost ten different groups from different disciplines set up experiments, each using their respective expertise. It was a very fortuitous coincidence that on the day of the Fleischmann-Pons announcement a large Pd-D₂O electrolytic cell commercially procured from the Milton Roy company of Ireland was ready to be switched on in the Neutron Physics Division. It used NaOD as electrolyte and was being adapted for generating pure D₂ gas for some hot fusion related experiments. This cell with 100 cm² of cathode surface area and 100 amps current capacity perhaps one of the largest cells to be experimented with to date in this field, generated a huge neutron burst and tritium on the 21st of April 1989. Other groups from BARC also reported detecting neutron emission and tritium production. A summary of the first BARC results was presented at the "Fifth International Conference on Emerging Nuclear Energy Systems" held at Karlsruhe, Germany in July 1989. A six monthly progress report titled "BARC Studies in Cold Fusion" (BARC 1500) was released in late 1989 boosting the case for the reality of the phenomenon at a time when the US DOE report projected a very negative picture.

The highlight of the early BARC studies was that several of the groups had independently observed both neutrons and tritium in Pd-D₂O electrolytic cells the tritium yield being several orders of magnitude larger than that of neutrons a phenomenon now commonly referred to as the branching ratio anomaly. Also BARC groups were the first and possibly only groups to date to carry out a statistical analysis of the neutron emission which indicates that a small part of the neutron emission is in the form of bursts of several tens to hundreds of neutrons within a very short duration of a few microseconds. Seen in the light of another early observation at BARC namely the spots in autoradiographs of post run titanium electrodes/targets/chips etc it points to the possibility of the phenomenon being localized both in space and time.

Unfortunately cold fusion related work died at BARC and indeed everywhere in India by the early 90s. But there are indications of a sea change in attitude to the subject! A one-day workshop was held at the National Institute of Advanced Studies at Bangalore on 9th January 2008 and attended by some leading scientists and engineers of India, and the present Director of BARC has agreed to host a three day International Workshop on Materials Issues related to CMNS devices sometime in February 2009.

The History of Cold Fusion in Italy 1989-2008

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The story of research on the science of the “Cold Fusion” phenomena in Italy is presented. When Fleischmann and Pons in 1989 announced the discovery of the Fleischmann-Pons effect there was an immediate interest in Italy and many organizations attempted to perform the FPE experiment. Many experiments were performed not only in the original “table top” electrochemical configuration but also experiments employing gas loading of the metal and efforts were made to detect other signatures, mostly nuclear, with varying success. The second ICCF was held at Lake Como in July 1991 and the proceedings of that conference were published by the Italian Physical Society. The evolution of the field in the years will be briefly described.

Country History on Japanese Work on Cold Fusion: Towards further development of Condensed Matter Nuclear Science

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Since the announced in 1989 by Professors Martin Fleischmann and Stan Pons, much work on the so-called cold fusion has been carried out in Japan as well as other countries.

Two months after the F-P announcement, the research group of room-temperature nuclear fusion was already established under the leadership of Prof. Ikegami of National Institute for Fusion Science. The group, initially consisting of about 40 persons (to be more than 100), started actively in June, 1989, with a support from the Grants-in-Aid for Scientific Research by Ministry of Education. Since then, many researchers and groups were involved in co-operative, systematic and organized studies. In addition, there have been individual studies which were performed independently from such kind of group; for example, those of Prof. Arata and Zhang.

Since the excellent works performed by Prof. Arata are introduced and fully discussed in the special session, we try to summarize other works in Japan, in the present report. From this point of view, the history can be divided into three periods: the 1st period is from the announcement of F-P to the ICCF3 Nagoya Conference (1989 - 1993), the 2nd period is during the New Hydrogen Energy (NHE) Project (1994 – 1999), and the 3rd after the NHE project (2000 – present).

We will show characteristics of investigations in each period as well as remarkable results, and will discuss what is required now for future development of CMNS research.

Status of Research on Low Energy Nuclear Reactions in Non-Equilibrium Condensed Matter in Russia Based on Publications in Reviewed Journals

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I. Introduction

Under the term LENR or CMNS (in more broad sense) we understand specific nuclear processes at very low kinetic energy of projectile nuclei (say, $kT < E_{\text{lab}} < 1 \text{ keV}$) that are enhanced by strictly non-equilibrium condensed matter/crystalline lattice environment. These peculiarities make LENR (and nuclear cross-sections) drastically distinctive from the nuclear reactions taking place in vacuum/plasma collision. In more broad sense the LENR/CMNS effects are also include nuclear, electrochemical, material science (condensed matter physics) and other aspects and can be considered as an interdisciplinary research area.

First experimental works on LENR (Discovery of neutron emissions during the fracture of LiD and heavy ice crystals) has been performed in USSR, by team headed by Prof. B.V. Deryaguin in 1985. Later their results on LiD were confirmed by M. Srinivasan et al (Phys. Lett A, 1997). Now this branch of LENR is famous as a “fracto-fusion”. Some theoretical considerations concerning barrier free DD-fusion in solids have also been presented by Visotsky and Kuzmin as early as in 1986. After discovery of deuterium role in the Pd cathode during electrolysis (by Fleischmann and Ponce in 1989) many groups in former USSR started their works on LENR. To support these works on government level already in April 1989 a special Council on Cold Fusion has been created in USSR Academy of Sciences headed by a vice-president of Academy academician Nefedov.

There were both positive (confirming F&P data) and negative reports on the effects of electrolysis (gas loading, glow discharge and so on) in Pd-Deuterium systems. Several groups reported huge amounts of excess heat and neutrons that later never were reproduced. The lack of expensive precise calorimeters for electrochemical experiments (USSR already had that time serious economical problems) turned LENR research in Russia after 1990 mostly to search for nuclear signatures of CMNS processes as well as for study of isotopic abundances in the cathodes after deuterium loading.

The summary of Russian research in LENR shows that in some areas of the CMNS research the Russian contribution had a crucial value. This areas include, but not limited by fracto-fusion, nuclear emissions during acoustic cavitation, glow discharge studies (isotopic shifts and soft X-ray emission first observed by Karabut *et al.*), energetic alpha particle emissions, and so on. These results would be compared with internationally recognized works.

Role of Russian Scientists in CMNS - Conference Proceedings 1991-2007

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It is observed historical & formal statistic analysis of the Russian scientists' personal activity (together with Ukrainian scientists) according to their publications in different Cold Fusion Conferences Proceedings. Among these conferences are following: 11 International Conferences on Cold Fusion (3-13 ICCF, 1992-2007); All Union Conference on Cold Nuclear Fusion (JINR-MSU, 1991); All Union Seminar on Chemistry & Technology of Hydrogen (Zarechnyi, 1991); 2-d International Symposium on Cold Fusion (Minsk, 1994); all 14 Russian Conferences on Cold Nuclear Transmutation (Abrau-Dyurso, Sochi, Dagomys, 1993-2006). It is also analyzed total number of Russian scientists publications in International Conferences on Cold Fusion compared to publications from other countries. This analysis has demonstrated the considerable contribution of Russian Scientific Community to the World Cold Nuclear Transmutation (Condensed Matter Nuclear Science) researches.

Physical Mechanisms in Theories of Condensed Matter Nuclear Science

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Theories of many-body systems are almost intractable because of the great number of combinations of effects that can be created. Nuclear physics, solid state physics, chemistry, and elementary particle physics each carve off and study a subset of the larger many-body problem. The Fleischmann-Pons effect provides a challenge for these fields, due to the observations of energy production at nuclear levels which is not accompanied by energetic radiation. Condensed Matter Nuclear Science (CMNS) brings back together nuclear structure physics and solid state physics and chemistry to address this and related effects.

The purpose of this paper is two-fold: first, to review important experiments in view of their input and impact on theory; second, to discuss a starting point for theory that is based on nucleons and electrons.

Theorists are always happiest when theoretical questions are settled by experiment. In the case of the Fleischmann-Pons excess heat effect, observations suggest that deuterons react to make 4He . However, the same experiments seem to shed little light on mechanism other than indicating strongly that a new physical mechanism is responsible, since the energy is not expressed through energetic particles. This motivates us to examine other kinds of experiments to see if there are clues which can provide theoretical input as to what mechanisms are involved.

Theorists are also pleased when there is a formulation that everyone can agree on to address a given problem. A many-body formulation based on nucleons and electrons has the potential to deal with nuclear physics, condensed matter physics, and chemical physics on a unified basis (adding particle physics to the list would require starting with quarks, which would result in a much more difficult starting place). It is possible within such a formulation to bring to the fore the parts of the problem one wishes to focus on through the construction of basis states. We illustrate this by examining examples from nuclear physics, solid-state physics, and CMNS, all on the same footing.

Exploring a Self-Sustaining Heater without Contamination

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In the past 19 years we did two things right: (1) Developing the selective resonant tunneling theory as a guide line for the experiment; (2) Pursuing the gas-loading experiment instead of the heavy water electrolysis experiment. These two topics established the base for a self-sustaining heater without contamination. Two important results would be reported in these two topics.

Thousands of data points from the National Nuclear Data Center for those major fusion cross-sections of D+T, D+D, D+He3, T+T, and T+He3 are compared with the NRL fitting formula with 5 parameters (A₁, A₂, A₃, A₄, and A₅ in Plasma Formulary, NRL/PL/6790-07-500):

$$\sigma(E) = \frac{1}{E} \left(\frac{1}{\exp\left[\frac{A_1}{\sqrt{E}}\right] - 1} \right) \left(A_5 + \frac{A_2}{(A_4 - A_3 E)^2 + 1} \right) \quad (1)$$

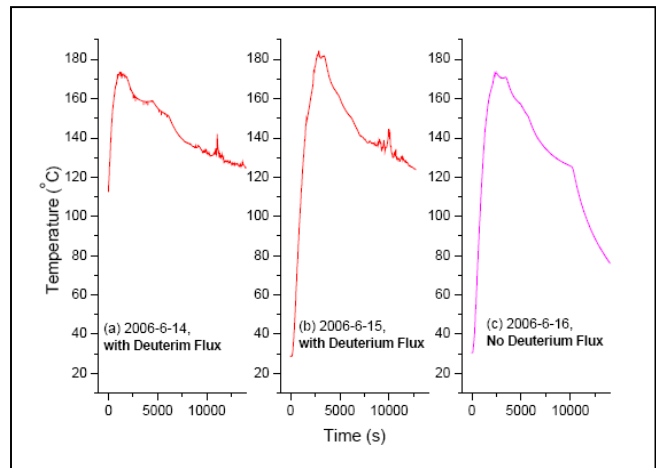
It could not reproduce the experimental values for the resonance peak as good as our 3-parameter formula (C₁, C₂, C₃ only) derived from selective resonant tunneling theory:

$$\sigma(E) = \frac{1}{E} \left(\frac{1}{\exp\left[\frac{Z_a Z_b e^2}{2\epsilon_0 \hbar} \sqrt{\frac{M_a}{2E}}\right] - 1} \right) \left(\frac{-4C_3 \left(\frac{\pi \hbar}{\mu}\right)^2 M_a}{(C_1 + C_2 E)^2 + \left(C_3 - \frac{2\pi}{\exp\left[\frac{Z_a Z_b e^2}{2\epsilon_0 \hbar} \sqrt{\frac{M_a}{2E}}\right] - 1}\right)^2} \right) \quad (2)$$

This clearly shows that the study of Condensed Matter Nuclear Science is just supplementary to our existing knowledge of nuclear physics without any violation of basic law of physics. The key

term, $\frac{2\pi}{\exp\left[\frac{\pi Z_a Z_b e^2}{\hbar} \sqrt{\frac{2M_a}{E}}\right] - 1}$, in the denominator of Eq.(2) strongly confirms the selectivity of resonant tunneling, and forms the physics basis of a nuclear energy source without nuclear contamination.

According to this selective resonant tunneling theory, a fine tuning procedure was proposed to approach a self-sustaining heater. Three plots show the reproducibility of excess heat and the correlation with the deuterium flux near the temperature 140°C.



Theory of Low-Energy Deuterium Fusion in Nano-Scale Metal Particles

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A consistent conventional theoretical description is presented for anomalous low-energy deuterium nuclear fusion in nano-scale metal particles.

The conventional deuterium fusion in free space proceeds via the following nuclear reactions: {1} $D+D \rightarrow p+T+4.03 \text{ MeV}$; {2} $D+D \rightarrow n+3\text{He}+3.27 \text{ MeV}$; and {3} $D+D \rightarrow 4\text{He}+\gamma+23.8 \text{ MeV}$. The cross-sections have been measured at intermediate energies ($\geq 10 \text{ keV}$), and are expected to be extremely small at low energies ($\leq 10 \text{ eV}$) due to the Coulomb barrier. The measured cross-sections have branching ratios: $(\sigma\{1\}, \sigma\{2\}, \sigma\{3\}) \approx (1, 1, 10^{-6})$.

From many experimental measurements by Fleischmann and Pons in 1989, and many others over 19 years since then, including the most recent work by Arata and Zhang, the following facts have been established. At ambient temperatures or low energies ($\leq 10 \text{ eV}$), deuterium fusion in metal proceeds via reactions: {4} $D(m) + D(m) \rightarrow p(m) + T(m) + 4.03 \text{ MeV (m)}$; {5} $D(m) + D(m) \rightarrow n(m) + 3\text{He}(m) + 3.27 \text{ MeV (m)}$; and {6} $D(m) + D(m) \rightarrow 4\text{He}(m) + 23.8 \text{ MeV (m)}$, where m represents a host metal lattice or particle. Reaction rate R for {6} is dominant, $R\{6\} \gg R\{4\}$ and $R\{6\} \gg R\{5\}$. Additional observations are $D/Pd \geq 1$, $H/D \ll 1$, and “heat after death”. The theory presented here is capable of explaining the above observations, and provides theoretical predictions which can be tested experimentally for the confirmation of the theory.

In 2000, a theoretical model of low-energy nuclear reaction in a quantum many-body system was developed to describe the anomalous ultra low-energy nuclear reaction [1-2]. Approximate ground-state solutions of many-body Schrodinger equation were obtained [3] and used to derive theoretical formulae for fusion rate for N identical Bose (integer-spin) nuclei confined in a trap (atomic cluster), and occupying the Bose-Einstein condensate (BEC) state. These theoretical formulae yield a prediction that the Coulomb interaction between two charged bosons is suppressed for the large N case and hence the conventional Gamow factor is absent. This prediction provides explanation for observed anomalous fusion rates for reactions {4}-{6}. More recently, the theory of BEC mechanism was extended to a mixed system of two species of Bose nuclei to obtain selection rules [4]. The selection rule provides explanations for the fact that $R\{6\} \gg R\{4\}$ and $R\{6\} \gg R\{5\}$ and also that purity of deuterium input, $H/D \ll 1$, is required. A more detailed description of the theoretical explanation will be presented along with suggested experimental tests of predictions of the theory and a discussion of the scalability of the fusion rates based on the theory.

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Resonant Electromagnetic-Dynamics Explains the Pons-Fleischmann Effect

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Infinite Energy Magazine, 5023 N. 38th St., Arlington, VA 22207

It has been widely believed that in order to explain the Pons-Fleischmann Excess Heat (PFEH) effect, it is necessary to explain how to “overcome” the conventional “Coulomb Barrier.” A somewhat subtler point has involved confusion about what actually constitutes “The Coulomb Barrier” and the fact that implicit in the assumption that it has “to be overcome” is the idea that two deuterons (d’s) acquire large relative momentum p , that p not change appreciably, except near the location where appreciable d-d overlap takes place, and that, as a consequence, the electromagnetic interaction (EMI) can be treated in a time-independent manner. In fact, although when two d’s, with large values of p , collide at a point, sufficient overlap does take place between them that nuclear fusion can take place, when the barrier is overcome in this manner, not only is it necessary for high-energy particles to be released, but the associated picture does not describe the relevant dynamics associated with the one d+d fusion reaction that produces helium-4, where (because a gamma ray is produced) the time dependence of the EMI plays a dominant role, not only when d-d overlap is appreciable, but at locations that are far from the reaction. An alternative picture has been suggested[1] in which, in order to minimize energy, in an ordered crystal lattice, appreciable d-d overlap can take place when the d’s occupy ion band states and by allowing p to change appreciably over short length scales, in a manner that depends on crystal lattice size. In fact, although this last picture illustrates overlap can occur, the picture is approximate because: 1. The overlap process is assumed to occur in a time-independent manner; and 2. The nuclear reaction (involving nuclear length scale changes in wave function overlap) is treated in a semi-classical limit, involving an approximate Fermi Golden Rule expression, in which the associated matrix element is modeled using a periodically distributed shift in the zero of kinetic energy at the locations where nuclear overlap is assumed to be possible. Formally, when non-linear coupling between many charged particles and many, low frequency photons is allowed to take place, it is possible to derive the results of this last model but also to extend the associated theory, using resonant forms of EMI, to situations involving finite, micrometer- and nanometer- scale, finite solids. These ideas not only provide a basis for conventional, electron energy band theory (which explains charge and heat transport in solids), but they also explain how through finite size effects, it is possible to create many of the kinds of effects envisioned by Giuliano Preparata. In the resulting picture, the notion of a collision, at a single point, involving two d’s, is replaced by a considerably more sophisticated picture in which many photons collide with d’s at many locations, in a rhythmic fashion (in which the rhythm is defined by periodic order). In the associated process, in a figurative sense, as opposed to “hitting each other” at a particular location, in a collision, the deuterons can be viewed as resonantly coupling to their environment, at many locations, and the “collision process” can be viewed almost as a form of “dance.”

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Optimal Operating Points in Active, Loaded Palladium Linked to Three Distinct Physical Regions

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Lattice-assisted nuclear reactions [LANR, cold fusion, LENR, CMNR] produce excess heat and other nuclear products such as helium-4 and tritium, if palladium is used under precise conditions, such as high loading with deuteron flux. The Three Region Hypothesis [3RH] resolves differences between several types of cold fusion by recognizing that the LANR reactions may exist in any one of three different physical locations. 3RH is consistent with a vast set of experimental data, which at present in absence of OOP-understanding, are not otherwise explicable.

3RH has been tested by a theoretical reconstruction. It does appear that there is a possible relationship between each of the three different types of physical locations to one of three different groups of observed Optimal Operating Point (OOP) manifolds. These describe different production rates of excess heat, tritium, and helium, known to characterize all LANR systems. Briefly, 3RH postulates that each of these OOP manifold groups represents different possible active sites of LANR in a group of specimens, or devices. 3RH is consistent with the complex behavior of palladium, its unusual binary alloy characteristics, and material science. This hypothesis is consistent with our previous report of (at least) two time constants characterizing 'heat after death' excess heat.

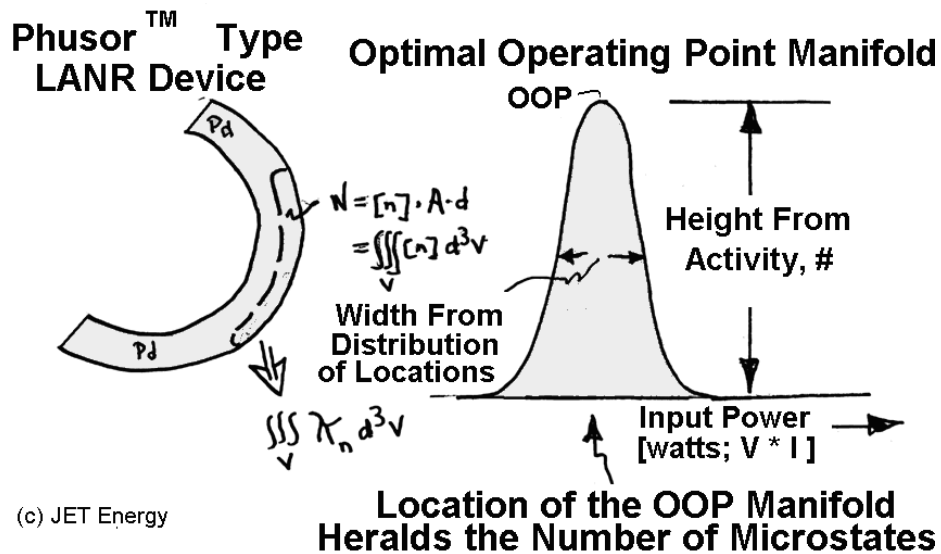


Figure 1 -Schematic linking a zone of hypothetical LANR foci (left) generating excess power gain linked to one optimal operating point manifold (right) shown along the input electrical power axis. The OOP height is proportional to the amount of helium-4, tritium, or excess heat produced.

Screening Potential for Nuclear Reactions in Condensed Matter

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It has been well known that two miracles are necessary to explain the cold fusion experiments. They are a huge reduction of the Coulomb barrier between two deuterons in metals and an anomalously large branching ratio of the d+d reaction leading to the α +X channel (X: energy transfer to the lattice). Such conditions are never realized for the free d+d fusion reaction. The study of nuclear reactions in metals by bombarding low-energy deuteron beams gives important information to discuss the miracles of cold fusion, especially for the Coulomb barrier between deuterons in metals.

In the present work, results so far obtained in low-energy beam experiments will be overviewed and two topics on the screening effects provided by condensed matter for the nuclear reactions will be discussed.

(1) Electronic screening: Nuclear reactions occurring in solid metals are usually considered to be affected by electronic screening, since target nuclei are surrounded by conduction electrons, i.e., a degenerate electron plasma. This effect has been studied by several authors. The screening potentials of the d+d [1-3], Li+d [4] and Li+p [5] reactions under such conditions were found to be very large: more than 300 eV for the d+d reactions in many metals.

The experimental results will be overviewed and discussed, since the origin of this large screening effect has not been clarified, yet.

(2) Ionic screening: We have developed another environment for low energy nuclear reactions; i.e., liquid metal Li, in which Li⁺ ions move freely in a sea of conduction electrons, and which has a much higher density ($\rho \sim 5 \times 10^{22}/\text{cm}^3$) than can be realized in laboratory gas plasmas. It is expected that in a low-temperature dense plasma, the classical ions contribute to the screening more strongly than the quantum electrons do, because of a difference of the mean kinetic energy of the particles under the equilibrium condition.

Recent results on the $^7\text{Li}+p$ and $^6\text{Li}+d$ reactions with liquid Li target will be shown. The effects of the solid-liquid phase transition are clearly seen in these reactions. It can be concluded that the ionic Debye screening is much stronger than the electronic screening in a low-temperature dense plasmas.

Finally, the importance of the large screening potential for low-energy nuclear reactions in condensed matter will be discussed.

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Accelerator measurements of the enhanced electron screening effect in d+d reactions with UHV conditions.

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The electron screening effect in nuclear reactions provides a mechanism for the deuteron fusion in metals at room temperature where it is grossly enhanced. The effect being one order of magnitude larger in the metal than in gaseous deuterium was verified under controlled conditions utilizing an electrostatic accelerator. Subsequently, also other groups made similar experiments giving reason for a theoretical description attempt by a model for stellar plasmas known as the Debye-Hückel model. The possibly very high movability of hydrogen in metals and target contaminations make screening experiments very difficult and error-prone. Profound scrutiny of the other experiments demonstrates that the observed unusual changes in the reaction yields are mainly due to deuteron density dynamics simulating the alleged screening energy values. The Debye-Hückel model could be clearly excluded for the description of the electron screening in metals both for nuclear reactions and radioactive decays. The specially adapted differential data analysis method employed enables the on-line monitoring of the target deuteron density thus assuring its stability. Therefore our screening energy results represent lower limits to the real ones only diminished by the remaining metal oxide layer on the target surfaces in the common high vacuum systems in nuclear physics set-ups which constitutes the main systematic error source. In order to remedy that problem the first ultra-high vacuum (UHV) experiment was performed studying the d+d reactions in a deuterized Zr target for which the experimental discrepancies are especially large. The total cross sections and angular distributions of the ${}^2\text{H}(d,p){}^3\text{H}$ and ${}^2\text{H}(d,n){}^3\text{He}$ reactions have been measured using a deuteron beam of energies between 8 and 30 keV provided by an electron cyclotron resonance ion source with excellent long-term stability. The cleanliness of the target surface has been substantially improved by combining Ar sputtering of the target and Auger spectroscopy. The resulting screening energy for Zr confirms the large value obtained in a previous experiment under high vacuum conditions and surpassed it considerably.

The D-D threshold resonance and enhanced electron screening

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Many experimental efforts performed in the last years seem to confirm that the D-D fusion reactions can reproducibly proceed at room temperature with a high intensity. However, the theoretical arguments against the cold fusion: an unexpectedly high penetration probability through the Coulomb barrier and the reaction branching ratio preferring 4He channel could not be consistently rebutted up to now. Here, we would like to present a simple explanation of both facts combining consequences resulting from the enhanced electron screening effect and a hypothetical D-D-threshold resonance.

The electron screening effect observed in accelerator experiments for the D-D fusion reactions in metallic environments when extrapolated to room temperature can increase nuclear reaction rates by 40 orders of magnitude compared to the deuterium molecule. An additional enhancement can be obtained due to a 0+ resonance in the compound nucleus 4He. Because of some theoretical arguments such a resonance should exist very close to the D-D reaction threshold and have large single particle strength. Thus, this resonance cannot decay by gamma emission and cannot be observed in other reaction channels. Due to the Coulomb barrier the resonance undergoes a narrowing process down to the width of about 10 eV and ought to decay mainly by internal conversion mechanisms. The latter enables the 4He channel to dominate the D-D fusion at room temperature.

Owned to the internal electron screening effect the position of the resonance can strongly change depending on the composition of the target material used and lead to alteration of the reaction rates at room temperature by many orders of magnitude. Theoretical calculations illustrating importance of the individual mechanisms proposed will be presented in detail.

Konrad Czerski. Main research fields are: low-energy nuclear physics, nuclear astrophysics, ion-matter interaction, fast electron dynamics, medical physics. MSc degree in nuclear physics at the Warsaw University, Poland (1981), PhD degree in nuclear physics at the Technische Universität Berlin, Germany (1993), habilitation on "Nuclear, Atomic and Astrophysical Aspects of Deuteron-Induced Reactions on Light Odd-Odd Nuclei at Very Low Energies" at the Technische Universität Berlin, Germany (2004). Research and teaching positions: Institute for Nuclear Studies, Warsaw, Poland (1981-1988), Technische Universität Berlin (1989-1994), Freie Universität Berlin (1995-1999), Hahn-Meitner-Institut, Berlin (2000-2004), since 2005 Professor for nuclear and medical physics at the University of Szczecin, Poland and private Professor at the Technische Universität Berlin, Germany. Author of first accelerator experiments (since 1993) demonstrating the enhanced electron screening in metallic environments and of numerous experimental and theoretical scientific articles on this subject.

A theoretical model for enhanced fusion reaction in metal deuterides in the solid matrix

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In contrast to the fusion reaction in a gaseous plasma, the situation in a solid (condensed matter state) is different in many subtle ways. For example, there can be lattice confinement of deuteron chains in defects or the deuteron sub-lattice [1]. Our study shows that the cross-section for fusion improves considerably if d-d pairs are located in linear (one-dimensional) chainlets or line defects. Such non-equilibrium defects can exist only in a solid matrix. Further, solids harbor lattice vibrational modes (quanta, phonons) whose longitudinal optical modes interact strongly with electrons and ions. One such interaction, resulting in potential inversion, causes localization of electron pairs on deuterons [2]. Thus we have strong screening of the nuclear repulsion due to these local pairs (local charged bosons: lochons) [1, 3].

We visualize the formation of dimerized one-dimensional chains e.g. (...D⁺D⁻ - D⁺D⁻ - D⁺D⁻...), where D⁻ harbors lochons. Further, there will be strong binding in the dimers, due to resonance exchange of the type D⁺D⁻ ↔ D⁻D⁺, which further close in on each other. The cross-section of the low-energy fusion reaction between D⁺ and D⁻ can be appreciable only for l = 0 angular momentum. The asymptotic expression of the cross-section for resonant tunneling is:

$$\sigma(a,b) = (\text{constant} / E_a) \exp [- (e^2 / \hbar v_r)(1 - \exp(- a_s / \lambda_L))],$$

where E_a is the kinetic energy of the incident particles, v_r is the relative speed of D⁺ to D⁻, e is the charge, a_s is the screening parameter, and λ_L is the deBroglie length of the lochons. Important features of this equation are the elimination of a factor of 2π in the exponential term (in going from a 3-D to a 1-D model) and the screening term (1 - exp(- a_s / λ_L)), which can be considered to be related to either the effective charge of the nuclei or their effective kinetic energy. The lochon screening increases this latter term even beyond the electron screening. Laser stimulation (not shown in the equation) introduces local optical potentials [2], which peak with the resonant surface-plasmon/polariton wave at the interface (e.g., PdD – gold).

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Dynamic Mechanism of TSC Condensation Motion

Akito Takahashi

Technova Inc. and Osaka University

The formation of 4D/TSC (tetrahedral symmetric condensate) at around T-site of regular PdD lattice under D-phonon excitation, or on topological (fractal) nano-scale surface of PdDx and/or along interface of metal-oxide-metal nano-composite was proposed as seeds of deuteron-cluster fusion to produce heat with helium-4 as ash. Dynamic motion of TSC condensation was quantitatively studied by the quantum-mechanical stochastic differential equation (Langevin equation) for many-body cluster systems of deuterons and electrons under Platonic symmetry, in our latest papers for ICCF13, ACS07 and Catania07 Meetings.

This paper gives further discussions and explanations on the time-dependent quantum-mechanical behaviors of electron-clouds in 4D/TSC condensation, in comparison with steady ground state electron orbits and their de Broglie wave lengths for D-atom and D₂ molecule. Electron orbit in a “d-e-d-e” quasi-molecular system of a face of 4D/TSC under time-dependent condensation makes spiral track finally getting to the center-of-mass point of TSC, with tail of time-varying effective wave length. Electron kinetic energy at t=0 is 19 eV, and it continuously increases during the condensation time (1.4007fs) reaching finally 57.6 keV at R_{dd}=25 fm. There is no ground state for 4D/TSC, in contrast with D₂ and D₃⁺ molecules which have steady ground states. Trapping potential of TSC was estimated to be -130.4 keV at R_{dd}=25 fm.

The role and merit of HMEQPET (heavy mass electronic quasi-particle expansion theory) method for approximating time-dependent TSC trapping potential and relating to the estimation of time-dependent Coulomb barrier penetration probabilities of 4d cluster is explained. HMEQPET provides a practical method for calculating time-dependent (hence time-averaged) fusion rate under TSC condensation, based on the Fermi's first golden rule.



Dr. Akito Takahashi is Professor Emeritus of Osaka University, Japan, and the former president of ISCMNS.

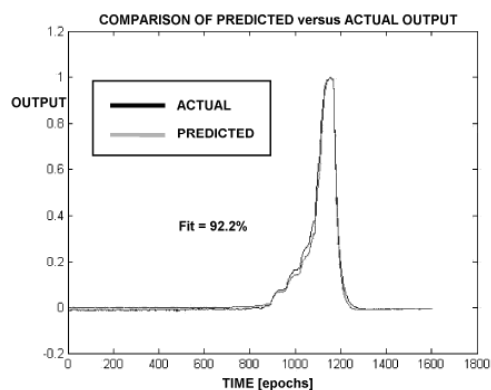
His background is nuclear physics, especially for fast and thermal neutron physics and nuclear reactions applied for fusion and fission energy systems. He has been studying CMNS for 19 years by experiment and theory.

Empirical System Identification (ESID) and Optimal Control of Lattice Assisted Nuclear Reaction (LANR) Devices

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At ICCF-1, Bass proposed using ESID technology to discover Hidden State-Vectors and their governing Dynamics in order to design feedback control systems for fusion reactors [1]. The goal was to manipulate the hidden variables to optimize reactor performance. At ICCF-7, Swartz introduced the concept of Optimal Operating Point (OOP) as the set of conditions under which the Power Gain from Input electrical energy to Output thermal energy is optimized [2]. The hypothesis which we investigated was whether these technologies may have improved efficacy when their complementary approaches are appropriately combined. For these experiments, data was obtained from an active Phusor™-type LANR device producing excess energy, as demonstrated by redundant calorimetry and heat flow measurements. The data was initially investigated by ESID technology using a hidden state-vector dimension $n = 6$, and matrices (A,B,C) of sizes respectively 6-by-6, 6-by-1, 1-by-6 based upon a Ho-Kalman-Leverrier algorithm (Bass 2006). This was found to be limited for this LANR work. The identified $n = 6$ system had poles too near to the boundary of the unit-circle in the complex-frequency plane $|z| = 1$, where the Leverrier algorithm is known to be numerically fragile. Therefore the ESID approach was repeated using the more statistically-sophisticated Canonical Variate Analysis (CVA), using the more numerically robust linear “subspace” approach (Wallace Larimore, Adaptics Inc., ADAPT_x). When this was applied, with the optimal state-vector dimension $n = 3$, the analysis demonstrated an excess Power Gain of circa 175%, in good agreement with the other independent methods which examined the specimen during the preliminary analysis. On reconstruction, the analysis had a rather stunning 92.2% accurate Prediction by ADAPT_x (Figure). There are two implications. First, ESID technology may offer advanced OOP control,



where the "predicted" output is derived based upon the empirically-identified calculations and the actual input. Our preliminary studies appear to confirm the effectiveness of this principle. Second, presently, OOP is found by manual experimentation and proprietary automated techniques. These may be augmented by a Kalman Observer to estimate the state-vector $x(k)$ in real time, and thereby enable the implementation of a State-Feedback Control Law to seek out the OOP automatically, and subsequently maintain the system operating as near to its OOP as is possible.

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The SHEEN Project: Theoretical Model on the hydrogen dynamics in CMNS experiments

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In the framework of the SHEEN Project, a special Research Project born within the synergy of FFF (Fulvio Frisone Foundation) and H.E.R.A. (Hydrogen Energy Research Agency) in the FFF Melilli Laboratory in Sicily, the models explaining the results on the hydrogen and deuterium dynamics in absorbing metals and metal alloys will be presented. Particular attention to the physical properties of the lattice during the hydrogen/deuterium absorption will be done.

The first question to find a theoretical answer is the correlation of lattice expansion versus the hydrogen and deuterium concentration in the PdH(D)_x system.

The second question regards the electrical relative resistance R/R₀ versus H,D. A possible explanation of this functional using a local model that consider the change in density and the lattice displacement will be shown.

The third question regards the metallurgical aspect, in particular the surface and the bulk annealing treatments. Find a model explaining the role of surface treatment like oxidation and the hardness of the sample in correlation with the dynamic of loading will be presented.

Excitation transfer and energy exchange processes for modeling the Fleischmann-Pons excess heat effect

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We have investigated new kinds of reaction mechanisms based on coherent excitation transfer and coherent energy exchange as candidates to account for excess heat production in the Fleischmann-Pons experiment. One goal has been to study the simplest possible models that can be relevant in terms of mechanism and functionality.

Since no energetic particles are observed commensurate with energy production, we have focused on models in which a large energy quantum is coherently down-converted into a great many smaller energy quanta. Coherent energy exchange between highly mismatched systems can be studied in the context of the spin-boson model. Although the effect can be demonstrated in this model, the amount of energy exchange is limited and the associated rates are too slow to account for the excess heat effect. When the model is augmented with loss, the effect becomes much stronger.

The coupling matrix elements for transitions from two deuteron states to the He-4 state are hindered because of tunneling through the Coulomb barrier. As a result, we do not expect this transition to be able to be effective in energy conversion. Consequently, we have focused on models involving first an excitation transfer step, followed by an energy exchange step. We find that generalized spin-boson models support this kind of two-step mechanism as a coherent process. Once again, the effect is too weak in the generalized spin-boson model. Once again, when the model is augmented with loss, the rates are greatly increased. The resulting model provides a strong candidate for a new reaction mechanism to account for excess heat production in Fleischmann-Pons experiments.



Peter L. Hagelstein: Graduated from MIT in 1976, PhD (MIT) in 1981, thesis: *Physics of x-ray lasers*; computational physics group leader in R-Program at LLNL in early 1980s; DoE E. O. Lawrence Prize for National Defense (1984); APS award for Excellence in Plasma Physics (1990); faculty, MIT EE&CS Department 1986-present; *Introductory Applied Quantum and Statistical Mechanics* (with Senturia and Orlando); co-chair ICCF10 (2003); Preparata Medal (2004); principal in 2004 DoE Review of LENR; recent research is on mechanisms for FPE excess heat, and thermal to electric energy conversion.

Pairing Interactions between Positive Nuclei Incorporated in Solid Structures

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Pairing interactions between hydrogen nuclei and between deuterium nuclei incorporated in the structures of real solids are subject of investigation in this paper. The author's research progress [1] in the field of disordered solids is connected with finding of electron energy pockets in the real solid structures. These pockets can accommodate only several electrons. The author has found the conditions about occupation of certain pocket in term of electrons in order that these electrons to create stable negative complex. It is found that a phonon exchange mechanism plays an essential role in creation of this complex. By itself this electron complex provides negative potential well and a model of "inversed" atom is created by the author. This model considers a stationary located negative electron charge acting as "negative nucleus" and positive charges (hydrogen nuclei or deuterium nuclei) occupying the corresponding "positive orbits", i.e. the positive charges (hydrogen nuclei or deuterium nuclei) are attracted by the "negative nucleus" and an "inversed" atom is formed. The influence of the solid medium on the Coulomb interactions in the "inversed" atom is accounted by the corresponding dielectric constant of the solid. Further Richardson's method [2] is used for investigation of pairing conditions in a hydrogen-hydrogen pair and in a deuterium-deuterium pair located on "positive orbits". The second quantization approach is used in determination of wave functions and of Hamiltonians. The wave functions of the pairs in both cases are determined in consideration of orbital angular momentum j . The pairing Hamiltonians are found and the corresponding interaction energies are determined for two cases of the total angular momentum I : $I = 0$ and $I \neq 0$. Analytical correlation between both the interaction energy and the pairing force strength parameter for certain j -orbital is found. The pairing binding energy is determined for even number of interacting nucleons (in fact the number of nucleons in a pair can be 2 if two hydrogen nuclei interact or this number can be 4 if the interaction is between two deuterium nuclei). The results show that hydrogen-hydrogen pair is stable only if it belongs to the "inversed" atom, i.e. if the "negative nucleus" associated with the energy pocket filled by electrons disappears as result the hydrogen-hydrogen pair will be destroyed. At the same time the results show that the deuterium-deuterium pair can remain stable particle after the disappearance of the "negative nucleus". A suggestion is made that the deuterium-deuterium pair may be considered as helium nucleus after destroying of the "inversed" atom.

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Dr. Dimiter Alexandrov is Associate Professor in the Department of Electrical Engineering, Lakehead University, Canada. He has graduated as Ph.D. in the Technical University of Sofia, Bulgaria, EU. Dr. Alexandrov's research is in the area of effects in disordered solids, and his research contributions are in the field of electronic band structures and properties of disordered solids, where he has found existence of new phenomena – tunnel optical absorption and excitons of the structure. Currently one of Dr. Alexandrov's research interests is behavior of nucleons incorporated in the structures of solids.

Metallurgical characterization of Pd electrodes employed in calorimetric experiments under electrochemical deuterium loading

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It is now well accepted that the excess heat production effect is strongly controlled by specific properties of the electrode materials. However, a definition of the role of each material-related issue is still lacking, as well as a complete understanding of the mechanism responsible for the observed effect.

This work follows a statistical method to approach this problem by performing a systematic metallurgical characterization of each sample, and organizing all the experimental data from several samples into a database. In this paper we report the outcome of the material database we have realized, collecting data from samples experimented and characterized by ENEA, SRI and NRL laboratories.

Electrode Surface Morphology Characterization by Atomic Force Microscopy

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The introduction of hydrogen into a metal during electrolysis of water involves primarily the metallic surface. Then, it is reasonable to assume that the surface morphology of the cathodes could play a role in the metal-hydride formation. Actually, a wide variety of surface features and profiles have been observed in the Pd cathodes typically employed in excess heat production experiments. These features are noted in both the as prepared samples and the electrolyzed ones. In order to establish a correlation between the occurrence of a particular surface morphology and calorimetric results, it is necessary to identify a useful metric with which to describe and compare the different surface morphologies.

In this work an approach based on atomic force microscopy (AFM) has been investigated, oriented toward the identification of parameters suitable for a pre-screening of the materials.

Francesca Sarto

PhD Solid State and Surface Physics. Fields of work: thin films, hydrogen isotopes surface interaction, electrochemical interfaces, surface analysis and characterization (SEM, AFM, SIMS), Infrared Spectroscopy, numerical methods for surface characterization.

Observation of Optical Phonon in Hydrogen Storage Pd Using Raman Spectroscopy

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The techniques of hydrogen loading in Pd are developed by many workers [1,2]. And the states of hydrogen in Pd attract many interests because they might be related to the nuclear reactions. In this study, we have tried to observe optical phonon induced by hydrogen-hydrogen interactions in Pd using Raman spectroscopy. This measurement can be done for the sample completely sealed in a glass tube cutting off the influence of the external air, because glass materials are Raman inactive. In the measurement chamber of spectroscopy device, scattered waves of the incident laser beam from the hydrogen storage Pd are detected and Raman shifts including the information about the optical phonon in the sample are derived.

If large changes in Raman spectra are found, they will provide information on the effects from the condensed states of hydrogen and nuclear reactions in Pd. As of now, we have not found them, but we have detected peaks of Raman shift at 56 meV both for PdH_x and PdD_x. The peaks for PdH_x are consistent with the data of Sherman et al. at 58.5 meV [3]. However, the peaks for PdD_x are inconsistent with Sherman's result at 39.7 meV [3].

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Biography

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Position; Associate Professor

Non-Thermal Near-IR Emission Linked with Excess Power Gain in High Impedance and Codeposition Phusor™ Type LANR Devices

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Non-thermal near-infrared (NT-NIR) light emission has been detected from loaded, active nickel and palladium Phusor™ type LANR devices by in situ monitoring. It is linked, and specific, to the devices' excess heat production, and not their physical temperature. This NT-NIR output has been observed for a variety of Phusor™ type LANR systems [e.g. Pd high impedance, codeposition, Ni with light water]. One important implication of the NT-NIR output is that it may be an important confirmation of the hypothesis that analyzed Bremsstrahlung under low temperatures, where there is a shift from penetrating ionizing radiation to skin-depth-locked infra-red radiation. The hypothesis is consistent with this experimental data in several systems during excess heat production.

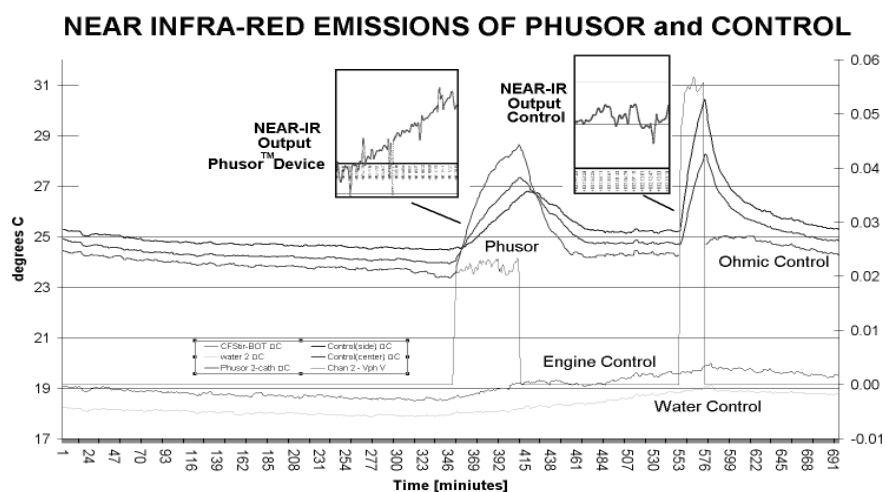


Figure 1 – Non-thermal Near-IR Emission from DAP Phusor

The two inserts show the near-IR outputs of a Phusor™ type LANR device and the control over time during each electrical input pulse. Below the two insets are some of the thermometry of the DAP codeposition Phusor LANR device and an ohmic thermal control. Excess energy was produced in the pulse on the left side of the figure, electrical energy delivered to the DAP Phusor™ LANR device. The pulse on the right side represents electrical energy delivered to a calibrated ohmic thermal control. Both thermal and near-IR outputs of the DAP Phusor can be seen during its excess energy phase. By contrast, for the thermal control, despite a higher temperature, there was not an equivalent rising emission observed in the near infrared.

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Investigation of Radiation Effects at Bubble Cavitation in Running Liquid

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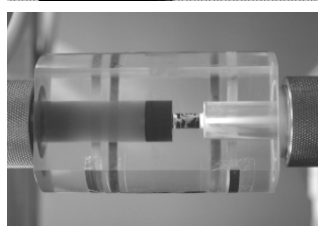
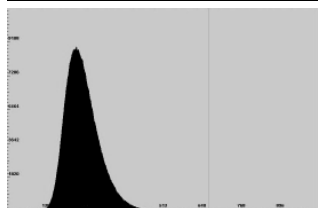
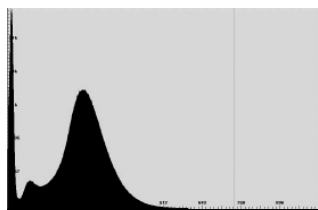
² *Kiev National Shevchenko University, Kiev, Ukraine*

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In our earlier work [1] the optical phenomena accompanying cavitation processes at directed motion of running liquids through thin dielectric channels were investigated.

In the present work the results of investigation of hard radiation processes connected with the same cavitation phenomena are presented and discussed.

At detailed examination we have found the critical regime of bubble cavitation that leads to stationary generation of X-radiation with energy about (or more) 1 KeV during all process of cavitation. This radiation is detected outside the cavitation chamber.



From one hand the reasons of generation of this radiation are obvious and are connected with bubble cavitation. Our numerous experiments have shown that the generation of this radiation takes place only in the case of special regime of active cavitation in running liquid. From the other hand this soft X-radiation can not transit through a volume of a liquid and thick (about 2 - 3 cm) plexiglas wall of the chamber and is generated by an exterior surface of the chamber. The soft part of this radiation corresponds to characteristic transitions of chamber atoms (e.g. C,N,O). We have observed that at using of additional cover of the chamber surface (e.g., made of fixed Cu powder) in a spectrum there are extra more hard spectral lines (see additional right peak on Fig 1).

In the case of using of thin additional resonant absorber the effect of screening of a soft part of radiation takes place (see Fig.2).

In this work the new method of generation of hard radiation outside the cavitation chamber is discussed.

This mechanism is connected with the sequential tandem of cavitation and shock-wave processes inside the chamber and in the volume of chamber wall in the case of perfect acoustic contact in this area. The result of this tandem action is the passing of cavitation energy from cavitation area through running liquids to atoms situated on the surface of the chamber. Shock excitation of these atoms lead to generation of X-radiation outside the cavitation chamber.

From our consideration follows that the same combined tandem takes place during creation of the directed bright light beam (see Fig.3) in the central part of working chamber (in the volume of squeezed fast spindle oil stream) at high pressure of spindle oil (about 70-80 atmospheres). These results were observed for the first time in [1].

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Bubble Driven Fusion

Roger Stringham
First Gate Energies

How can two deuterons produce heat and ^4He as fusion products? One prospect is sonofusion (SF), boosting a naturally occurring phenomenon where cavitation induces a transient high-density environment, thus creating a unique fusion path to ^4He and heat. What is increasingly evident is that high-density experiments of inertial confined fusion, ICF, and astrophysical relations of fermions and bosons, show a path to sonofusion products. Sonofusion focuses around implantation of nanometer jet volumes and pico second time scales. Several high-density systems like those of white dwarf stars (WDS), muon fusion (MF), z-pinch systems, and ICF have influence over this model path. The above and experimental evidence below shows the way to sonofusion's electromagnetic high-density driven systems.

The experimental part of this paper draws from many years of compelling results pointing to fusion events in target foils produced by transient cavitation bubbles, TCBs, in D_2O . TCBs produce high-density plasma jets, which are related to sonoluminescence, SL, during the TCBs collapse process, where the jets are further compressed by electromagnetic fields [1]. SL is used to monitor sonofusion. Jets implant the target foil forming deuteron clusters. The transient deuteron clusters are stabilized by their high-density (close packed structure), strong force influence, and boson wave function. The cluster density is such that a DD fusion event(s) occur. The conversion of fusion energy to a lattice heat pulse is shown in the many scanning electron microscope, SEM, photos of target foil surface ejecta sites. In piezo systems that resonate at 20 KHz, ejecta were expelled into the circulating D_2O , where the fusion ash and heat are circulated and measured. The experimental mass spectral measurements of ^4He ash products, at 550 ppm, were measured in a Department of Energy laboratory [2]. This experiment produced 80 watts (^4He) of heat for a 19 hr TCB run. In a system that resonates at 1.6 MHz, SEM photos of ejecta sites were not apparent, as the number of deuterons per jet was 1/1000 of the 20 KHz piezo systems. 1.6 MHz produce much smaller but more numerous jets with similar energy densities. 1.6 MHz is very close to the resonance of the target foil. Heat measurements showed excess heat, Q_x , that increased with acoustic power input, Q_a . The power input, Q_i , was varied from 4 to 50 watts where Q_x was 1 to 40 watts [3,4]. Future work should lock the piezo resonant frequency to that of the natural resonance of target foils and the use of higher Z target foils.

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Roger Stringham, a grad from UC Berkeley in 1957-Physical Chemistry. Pursued an artistic career then joined SRI in 1960 where he followed a career in research for 15 years. In 1975 at SAIC he was operations director of the chemistry lab. In 1987 he started RR Research studying cavitation applications. In 1989 he formed Photosonication Consulting that in 1992 became EQuest and then in 1998, First Gate. All engaged in the experimental study of cavitation as it relates to excess heat.

Excess Heat Triggering by Nd:NYW Laser in a D/Pd Gas-Loading System

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On the basis of former experiments of excess heat triggering by He-Ne [1] and YAG [2] lasers, Nd³⁺:NYW laser here was used to a D/Pd gas-loading system for the same purpose. The laser used here has a similar wave length output ($\lambda=532\text{nm}$) and different modes (pulse and continuous). The results showed that there was nearly the same amount of excess power output comparing with the former experiments. And the pulse laser performed a better behavior in excess heat triggering than that in the continuous. The optimistic data indicated that there was a largest heat response when the laser output was 20mW and the loading ratio (ρ) = 0.17, which corresponded to an excess power density of nearly 0.2kW/cm³ Pd. The work indicated that the excess heat triggering by lasers is an effective and promising way and gas-loading system is a better system to “CMNR” research because the low energy laser has a coherent frequency to the metallic lattice and gas-loading system has a higher sensibility than that in the electrolysis in heat-detecting. According to the model raised by Li[3] there should have been a series of synergetic factors in crystal lattice if two nuclei inside collide and fuse into a behavior one through a tunneling manner.

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Heat Generation during Hydrogenation of Carbon (Phenanthrene)

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We observed anomalous heat generation while heating a small quantity of phenanthrene that was placed in a cylinder with a Pt catalyzer and filled with high pressure hydrogen gas. It is very difficult to explain the total energy generation as the product of a conventional chemical reaction, because after the experiment almost of all phenanthrene and hydrogen gas remained as it was initially. There were no reaction products such as other chemical compounds. The heat generation sometimes reached to 0.1 kW and continued for several hours. Moreover, we have confirmed γ -ray emission during the experiment. However, the correspondence between the heat generation and the gamma emission was not good. We have confirmed the result with high reproducibility by controlling the temperature and the pressure of the reactor.



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Major study: Applied physics, Nuclear energy, Metallurgy

Electric and Heat Measurements in High Voltage Electrolysis Cell Experiments

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The experimental researches of heat and high-energy processes occurring in the cathode solid medium in the high voltage electrolysis cell presented. The Excess Heat power was registered in experiments with High-Voltage Electrolysis (up to 1000 V and more). The pulse- periodic electrical power supply was used. The high-voltage electrolysis device (as a water-cooled flow calorimeter), consisted of a quartz tube with an additional circuit for a working fluid. The anode and cathode units were placed inside the tube. To circulate the working fluid a mixer was installed inside the circuit. Three sets of experiments were carried out at the following High Voltage Electrolysis operating parameters: Electrolysis in light water (H₂O) with a Ni cathode, Electrolysis in heavy water (H₂O) with a Pd cathode, Electrolysis in heavy water (D₂O) with a Pd cathode. Excess Heat power registered in the experiments with H₂O – Ni and D₂O – Pd systems.

Quantitative Spatial Analysis of Pd/D Co-Deposition Induced Nuclear Particle Tracks

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Li¹, Oriani², Miley³, Lipson⁴ and Boss^{4,5}, have used CR-39 in CMNS experiments. We have employed an automated scanner to quantitatively resolve charged particle and neutron energy distributions by an analysis of incident and recoil particle angular distributions by a quantitative spatial analysis of the particle tracks. The analysis consists of scanning both surfaces of an etched CR-39 detector resulting in approximately 1000 frames of data noting each track's x,y coordinate, ellipticity and other factors. Repeated etching and re-scanning of the same detector has supported the nuclear origin of these tracks. Triple tracks, indicative of > 10 MeV neutron breakup of ¹²C into three α particles, have been observed. We have reported tracks on both sides of the CR-39, implying either various, extremely energetic charged particles or neutron recoil particles. The purpose of this paper is to distinguish among these particle species.

CR-39 is compromised in co-deposition experiments by scattered charged particle energy loss in the electrolyte, high track densities and chemical damage. Chemical damage and non-nuclear track origins can be identified and mitigated. Electrolyte energy losses can be estimated from published LET curves. The non-nuclear track origin due to conjectured corona discharge or electrolytic action has been ruled out by using an intervening window between the electrolyte and the CR-39. The thin plastic windows also act as charged particle filters and polyethylene is an effective neutron radiator. ²⁴¹Am and ^{234,235,238}U α sources allow comparisons among co-deposition track sizes and known α track energy distributions. These tracks have been matched against an α track etch computer model. Consequently, we can spatially correlate charged particle species and neutron particle recoil tracks with the cathode, infer particle species and energies, and suggest probable nuclear reactions by ratioing the number of the various particle species observed. These reactions include conventional primary DD fusion pathways with the expected branching ratios and reaction products, and secondary DT fusion pathways.

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Can Established Physical Principles Explain Solid-State Fusion?

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This report examines whether low energy nuclear fusion can possibly conform to fundamental laws of physics. New evidence examined here may well explain two heretofore deficiencies cited as obstacles to a conventional physics explanation. These are the lack of a sufficient deuteron coupling mechanism and the lack of certain nuclear by-products. The concept that heavy electrons (fermions, pseudo-particles) are able to screen deuterons may have been dismissed too early. In this paper we show that heavy electrons may cause a high degree of localization, a central effect that is needed in the screening process. The more localized a pseudo-particle's charge the more it acts like a muon, which is well known to produce a screening effect and fusions of hydrogen nuclei. Many heavy electron (heavy fermion) materials exist, and in many of these, an increase in electron localization on lattice sites has already been seen experimentally. The lack of nuclear by-products may in fact be explained by a physically reasonable interaction between two to four deuterons in which only easily absorbed alpha particles and low energy gammas are produced. The thesis is that when a single particle alpha is produced as a free particle the only way kinetic energy may be exhibited and momentum conserved is through the emission of a particle to which it may react. Hence in a multi-particle situation, such as occurs when multiple deuterons interact, momentum may be conserved without small particle ejection, explaining the lack of nuclear by-products. Easily absorbed alphas are absorbed before they can exit an electrolysis experiment.

Remote Demonstration of Heat from Pd Black at Elevated Temperature on Exposure to D₂

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The author will attempt a real time experiment to demonstrate heat release from gas activation of Pd black. The experiment will be run in New Mexico and controlled via computer connection at the conference. The sample was made with small crystals of palladium located within a yttrium-stabilized zirconium oxide ceramic. These crystals were formed from Pd with additions of cobalt, cerium, rhodium and thorium from heavy water solutions of metal salts via borohydride reduction. The samples will then be loaded using a deuterium and hydrogen gas system. A calorimeter was constructed using identical wells located within a single large brass rod. The brass containing both the sample and control are placed in a "sand bath" and held at approximately 250 C. The sample will be loaded with deuterium and control with hydrogen. The thermal output of about 1 watt will be followed as a function of time.

The demonstration will be begun by simultaneously exposing the sample to deuterium and the control to hydrogen at approximately 15 atmospheres of pressure. The calibration constant previously found from resistive calibration will be used to estimate the net thermal output based on the temperature differences. The energy output will be followed day by day from the integrated sum of the estimated power output.

An experimental device, built to test the hypothesis of "pico-chemistry" (chemistry at picometer distance) – Implications in the LENR field

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The concept of "pico-chemistry" (chemistry at picometer distances) has recently been presented [1], to explain phenomenon observed in the field of LENR. In "pico-chemistry", activation energies are some ten times higher than what is observed in chemistry (20 to 50 eV, compared to 2 to 3 eV). These levels of energies are not easy to generate and reproduce in usual experimental systems (catalysis, low pressure discharges...). An experimental device has thus been built to generate protons (deuterons) having the required range of energies. It is anticipated that controlling this level of energy will considerably increase the reproducibility in the field.

This device will be described and the experiment plan devised to assess the reality of "pico-chemistry" will be presented.

Finally, the main characteristics of "pico-chemistry" will be given and its predictions will be compared to known experimental results in the LENR field. It will be seen that this simple working hypothesis can explain most of these results.

- [1] J. Dufour "Very sizeable increase of gravitation at pico-meter distance: A novel working hypothesis to explain anomalous heat effects and apparent transmutations in certain metal/hydrogen systems" *J. Condensed Matter Nucl. Sci.* I (2007) 1-15



Jacques Dufour

Born March 14, 1938

1958 Diploma from «Ecole Nationale Supérieure des Mines de Paris»

1963 Penarroya mining company

1964 Shell group of companies. Various positions in refineries, head quarters, commercial organization and research (in France and in the Netherlands).

1988 Director of scientific relations for Shell group in France.

1993 Project leader in "Laboratoire des Sciences Nucléaires" (CNAM). - Anomalous heat effects in certain metal/hydrogen systems -

Research into Energy Spectra of X-ray Emission from Solid Cathode Medium During the High Current Glow Discharge Operation and after the Glow Discharge Current Switch Off

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The experiments were carried out using a device of high-current glow discharge, which consisted of a water-cooling vacuum chamber, water-cooling cathode and anode units. X-ray emission was removed through a diagnostic window placed above the cathode. The discharge was realized in He, H₂ and D₂ at the pressure up to 10 Torr using the cathode samples made of Al, Sc, Ti, Ni, Mo, Pd, Ta, W, at current up to 200 mA and discharge voltage of 3900-4300 V. The pulse-periodical power supply of the glow discharge was used.

The X-ray spectra were registered in film using the curved mica crystal X-ray spectrometer. The following modes were brought during the experiments: 1- diffusion X-ray emission was observed in the form of separate X-ray flashes (up to 10⁵ X-ray flashes/sec and up to 10⁴ X-ray quanta in a beam). 2- emission of X-ray beams by small angular divergence occurs during the discharge burning and up to 100 msec and more after the current turning out. The X-ray spectrum were registered both as bands of the continuum with energies ranging 0.6 - 10.0 keV and as spots resulting from the emission of series of high-density monoenergetic X-ray beams (with energies of 0.6 - 10.0 keV) characterized by small angular divergence. The spectra were repeatedly recorded during the Glow Discharge operation and after the Glow Discharge current switch off (for up to 20 hours afterwards). All the experimental results have 100% reproducibility. The obtained results were the direct experimental evidence of existing the excited metastable energy levels with the energy of 0.6-10.0 keV in the solid of the cathode sample.

Nuclear or not nuclear, how to decide?

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A schematic diagram illustrating evolution from protoscience toward science has been shown at Catania conference, in October 2007. This paper will contain a similar diagram illustrating evolution toward accepted interpretations of experimental results. This will be followed by comments and observations based on the diagram, and on recently reported CMNS results. The emphasis will be on the use of CR-39 detectors, and on scientific methodology, as it applies to CMNS field.

Stimulation of Optical Phonons in Deuterated Palladium

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This work reports on progress made since 2007 in the triggering of excess power by terahertz stimulation of deuterated palladium. The stimulation was provided by tuning dual lasers to one of three specific beat frequencies corresponding to the known optical phonon frequencies of deuterated palladium (8, 15, 20 THz).

Results suggest that optical phonons may be involved in the Fleischmann-Pons effect, giving preliminary support to Hagelstein's phonon theory. The importance of laser beam polarization is also demonstrated, confirming earlier work reported by Violante *et al.* and by Letts and Cravens.



Dennis Letts has been working on electrochemical heat systems since 1990. He has built over 600 cells to study deuterium in palladium systems. He has pioneered the use of radio frequencies and lasers to trigger exothermic events in D-Pd electrochemical cells.

A high accuracy calorimeter for cold fusion studies

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Calorimetry is conceptually simple but considerable effort is required to reduce systematic errors to acceptable levels. Since 1989, we have designed and constructed a dozen calorimeter systems for cold fusion research. Each of these systems provided valuable experience in error detection and correction. The culmination of our efforts, an instrument with a design accuracy of 0.1% relative, is nicknamed MOAC (Mother Of All Calorimeters). This paper provides a description of MOAC and presents some pertinent calorimetric results.

Review of Fleischmann-Pons Effects Using Palladium-Boron Cathodes

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Various samples of Pd-B alloys prepared at the Naval Research Laboratory (NRL) have been investigated for the Fleischmann-Pons Effect (FPE) at four laboratories using four different calorimetric systems. Initial studies using the China Lake calorimeters gave excess heat production in seven out of eight experiments for NRL Pd-B alloys. The best China Lake experiment showed very early excess power production (50 mW) that gradually increased over 48 days to values exceeding 300 mW. A more detailed study of a Pd-B alloy was conducted at the New Hydrogen Energy (NHE) laboratory at Sapporo, Japan using the Fleischmann-Pons (F-P) Dewar calorimetric system. Similar to the previous China Lake results, very early excess power was detected, and later excess power measurements gave peaks exceeding 350 mW. During the boil-off phase of this experiment, the excess power attained 9 W (9000 mW). Complete calorimetric results for this experiment will be presented including three independent analyses of the same experimental data. Two patents have been issued involving the NRL Pd-B alloys [1].

Samples of NRL palladium-boron alloys were later transferred to two other laboratories. Two samples tested by Scott Little in Texas failed to demonstrate measurable excess power. Two Pd-B samples supplied to Edmund Storms in New Mexico also failed to exhibit the FPE. A major difference from previous studies that showed excess power was the use of closed calorimetric systems by both the Texas and New Mexico laboratories. There were also several other experimental differences that may be important. The China Lake and NHE studies were all performed using open isoperibolic calorimeters with similar experimental preparations.

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Dr. Melvin H. Miles received his Ph.D. in Physical Chemistry from the University of Utah followed by a NATO Fellowship to work with Dr. Heinz Gerischer in electrochemistry at the Technical University in Munich, Germany. His career includes 28 years as a research scientist for the Navy and a total of fourteen years teaching at Middle Tennessee State University, Bates College in Maine, and at the University of LaVerne. He is presently working on thermal batteries as a contractor for the Navy and also has a private funding for cold fusion research. Dr. Miles has more than 200 scientific publications. As illustrated, he received the Asti Award (Italy) for his cold fusion research in 1999.

Phase Properties of Sonoluminescence and a Possibility of Self-Reproduced Nuclear Fusion during Cavitation

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According to a series of theoretical and experimental works, the reaction of nuclear fusion during ultrasonic cavitation is possible in some organic liquids containing deuterium [1-3]. One of the important features of this phenomenon is the necessary activation of the cavitation process by energetic particles – fast neutrons or α -particles. Until now, no conditions are known for self-sustained nuclear fusion under the action of cavitation. The difficulty of realization of self-sustained nuclear fusion in this case is connected with the fact that neutron emission from $D+D \rightarrow {}^3\text{He}+n$ reaction of synthesis, and the moment of start of cavitation are separated by a considerable time interval. Thus, there is a problem in using neutrons from fusion reaction itself for restarting the process of cavitation at an appropriate moment. Experimental data on phase characteristic of bubble pulsations in case of two-bubble mode of sonoluminescence are presented, and two ways of solving the above problem are proposed. First of them is based on a so-called few-bubble mode of acoustic cavitation, when conditions for existence of at least two centers of trapped pulsing bubbles are produced. In that case, the bubble pulsations at different centers occur with a phase shift corresponding to a time interval between the moment of cavitation start and that of neutron emission from the reaction of synthesis. Another variant can be carried out in an array of the resonators excited with appropriate phase shifts. In addition, experimental set-up for producing super-high temperature during acoustic cavitation is described, and alternative applications of this device for synthesis of carbon nano-materials, including synthetic diamonds, are discussed.

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Dissertation: Joint Institute for Nuclear research, Dubna, Russia

Present position: Leading researcher, Institute in Physical-Technical Problems, Dubna, Russia

Field of work: from 1998 – Sonoluminescence, Cavitation fusion, Molecular-Nuclear transitions

Enhancement of the Processes of Nucleus Decay

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Processes of transmutation of radioactive isotopes in natural uranium during bombardment by low energy ions of deuterium and hydrogen in glow discharge (GD) and in electrolysis of light and heavy water were investigated earlier [1-3].

The results show that the intensities of alpha, beta, and gamma emissions increase after exposure to protons or deuterons in GD or electrolysis. The increase of gamma radiation in peaks produced by ²³¹Th after GD in hydrogen or deuterium plasma was determined with high resolution gamma ray spectroscopy. The analysis of gamma spectra shows that the influence of deuterium ions in GD increases the rate of formation of the excited states of ²³¹Th. The characteristic x-ray peak corresponding to the isotope ²³¹Pa was also detected.

The data obtained after irradiation in GD were compared with the astrophysical data in gamma spectrometers used in astrophysical research. The data about rate of formation of the excited states of ²³¹Th in gamma ray spectrometer SPI (program INTEGRAL) from impurity isotopes ²³⁵U are obtained. Impurity isotopes ²³⁵U are also obtained by preflight studying of a background gamma spectrum of the spectrometer GRIS. The rate of decay of impurity ²³⁵U at sea level is lower than in near-earth orbits.

This effect is possible to explain from the point of view of the assumption of higher concentrations of neutrinos with increasing distance from the earth. Reactions for the processes with neutrinos, taking into account spin and parity, are offered. On this basis and an available estimation of cross-sections of electromagnetic interactions with neutrinos, the hypothesis about the contribution of neutrinos in processes of radioactive nucleus decay is offered.

Detection of low-energy processes of enhancement of radioactive nucleus decay is an important step in the creation of new energy.

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Electrical Breakeven from LANR Phusor Device Systems: Relative Limitations of Thermal Loss in Feedback Loop

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In 1996, Hal Fox's 'Fusion Facts' reported that our early Phusor-type device had generated over-unity excess energy as electricity and had lit up a small LED. Thereafter, our success progressed to a low power fluorescent light, but the real goal remains: self-sustaining generation of electricity. For over two decades, our research has led to a new kind of Pd/D₂O/Pt, Pd/D₂O/Au and other engineered structures which exhibit impressive energy gain and fairly good reproducibility. Despite limitations of Carnot efficiency, poor thermoelectric conversion efficiencies (tried so far with a variety of devices), we attempted to anticipate driving these devices in self-sustaining mode [1], but there are major limitations to achieving a self-sustaining electricity-generating system using LANR. As a result, we have collected a significant amount of unexpected scientific data regarding the construction of this type of self-sustaining LANR systems.

Electrical Breakeven Losses in Feedback Loop

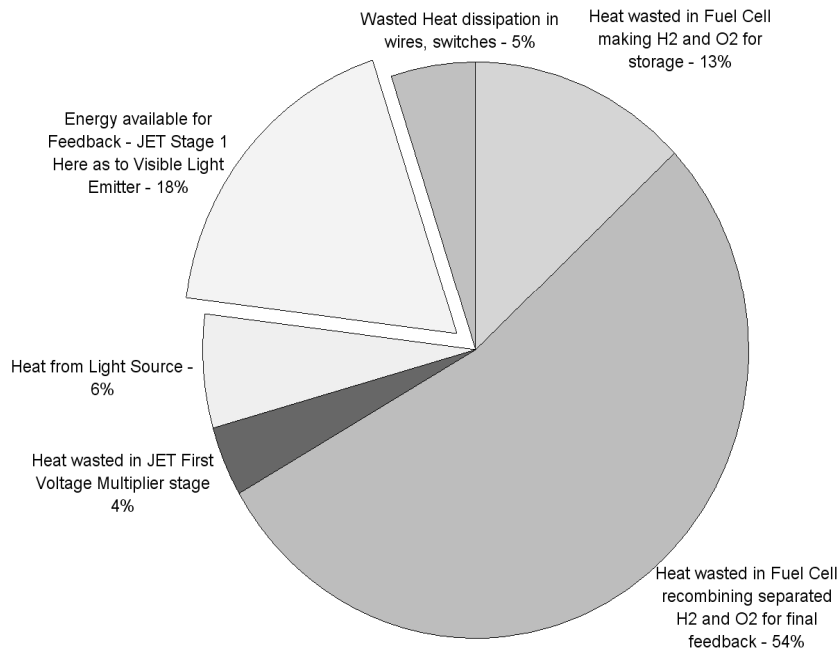


Figure 1 – Pie Chart of Thermal Losses in the Feedback loop to Understand Potential Difficulties in Creating a Self-sustaining Electric Source from LANR.

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Auger and Mass Spectroscopy of anomalous Ag concentrations on electrolyzed Pd

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Palladium cathode(s) which, after electrolysis, had shown multiple localized spots of anomalous silver concentration (exceeding 5% as measured by SEM using EDS spectroscopy) were further analyzed by Auger and Mass spectroscopy. A series of SEM images for each spot were used to locate, as reliably as possible, the same spots for Auger and Mass spectroscopy which had shown high silver concentrations by EDS. Sputter etching, a feature of both these techniques, provided depth profiles of local surface compositions. These will be presented and discussed in comparison with each other and with the EDS results.



Winthrop Williams received the ACS Outstanding Achievement in Chemistry award in 1979 as a high school junior, and went on to receive his Ph.D. in Physics in 1992 from the University of California at Berkeley, where, in 1989 as a graduate student, he performed a gas loading experiment using CR-39 to search (unsuccessfully) for low energy nuclear reactions in palladium and titanium foils. He presented more recent results using CR-39 at the 2007 APS conference in Denver.

Construction of a Seebeck Envelope Calorimeter and Reproducibility of Excess Heat

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A Seebeck Envelope Calorimeter (SEC) was designed, built and set up in our laboratory. The measuring vessel was $26 \times 26 \times 26 \text{ cm}^3$ (17.6 L). 18,796 thermocouples were used to measure the heat-flow from the vessel walls to the outer walls, for which temperature was controlled within 0.01°C from 0 to 100°C by a refrigerating/heating circulator. Homogeneity of temperature in the measuring vessel was improved by a fan with constant power. Calibration was performed with an electrical heater, with input power of 0.1 to 30 W. The device constant was about 6 W/V, and the time constant was 5 minutes. This calorimeter can be utilized for studies of the kinetics and thermodynamics of decimeter-size systems. Dash-type cells [1-2] were tested in this calorimeter. Both isoperibolic calorimeter (5 runs) and SEC (6 runs) measured excess heat with a Pd cathode of $25 \times 25 \times 0.3 \text{ mm}^3$; the SEC showed the excess heat was 0.15 ± 0.02 to $0.35 \pm 0.02 \text{ W}$ (average value is 0.27 W) with applied current of 3 A.

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Dr. Wu-Shou Zhang, Associate Professor, Institute of Chemistry, Chinese Academy of Sciences, Beijing, China. Born in 1968. Obtained degrees of MS (1993) and PhD (1996) on theoretical physics in Graduate School, Chinese Academy of Engineering Physics, Beijing, China. He has been involved in the cold fusion field since 1991. Related works include numerical simulation of gas discharge system and Pd-D kinetics and measurements of nuclear products. Excess heat in Pd-D₂O system and calorimetry are the focus in recent years.

Induced Molecular-Nuclear Transitions: “Molecular-Nuclear Laser”?

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An effect similar to a “molecular-nuclear laser” is predicted, and the first estimates of the probability of this effect are presented.

Earlier, [1-3] a possibility of a considerable increasing of nuclear fusion in some molecules due to near threshold resonances in final nuclei was shown. In this case the physical reason of the possibility of fusion is associated with a long tail of wave function of final nuclear resonance state (NRS). Wave function of this NRS has a form of outgoing spherical wave decreasing as $1/R$ with distance R , and not exponentially as in general. Accordingly, the overlap integral determining the transition probability is not negligibly small. The necessary condition for this effect is the identity of energies of the initial (molecular) state and that of NRS in final nucleus. This situation takes place, particularly, in $^{18}\text{Ne} - \text{H}_2\text{O}$, and $^8\text{Be} - ^6\text{LiD}$ systems. The energies of the above molecular systems are nearly identical to the energies of NRS in the final nuclei produced by fusion. Nevertheless, uncertainty in the present nuclear data does not give one to know whether the energies of non-bound system (molecular) are lower or higher than that of the final NRS. If the molecular energy is few keV over the energy of NRS, then the molecular-nuclear (MN) complex is similar in certain sense to a two-level atomic system in coherent quantum amplification and laser physics. A crucial difference between atomic and MN systems: no special pumping up is necessary for producing an active medium in the MN case. The role of active medium belongs to the initial molecule itself. Thus, external irradiation of the system by radiation in keV range can stimulate MN transitions. The phenomenon can be observed by measurements of coincidences between low energy (few keV-range) MN radiation, and high energy (MeV- range) emission from the final nuclei. Particularly, in $\text{H}_2\text{O} \rightarrow ^{18}\text{Ne}$ process, γ -quanta with $E_\gamma = 4.522$ MeV is expected, and in $^6\text{LiD} \rightarrow ^8\text{Be}$ case, two α -particles (each with $E_\alpha \sim 11.2$ MeV) has to be emitted. Thus, an effect similar to a “molecular-nuclear laser” is predicted. From the optimistic standpoint it can in principle be considered as a new source of nuclear energy (if the effect is proved experimentally): the estimate of energy yield in case of water is about 0.5 MeV/a.m.u. that is comparable to the energy yield in nuclear fission.

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Gas Generation in Glow Discharge Experiment

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There are many glow discharge experiments reported in the literature [1]. In the electrolytic cells, when the DC voltage is increased, it follows a characteristic I-V curve. Above certain voltage, the glow discharge appears at the electrode. At the same time a lot of gases were generated and excess heat was measured, in addition to extra nuclear elements detected. There were theories trying to explain these effects in the past [2], but none can give complete explanations. In this paper we present a somewhat different view point for the gas generation and the high temperatures attained at the electrode.

It has been known for some time that a Brown's gas is produced in an electrolytic cell under conditions. It is generated at relatively low temperatures (~ 25°C) and has very peculiar properties when ignited. A torch made with this gas can reach a temperature of 4000°C. It has been speculated as a promising clean future energy resource from water, but so far very little information about its physical parameters and properties are known.

We have performed the preliminary experiments related to this gas with DC, and pulsed DC. Some anomalies in the volumes of gas generated were observed. This will be explained in terms of a different concept of water which coexisted as a gas along with the other normal gases.

It is believed that the formation of the gas and its ignition may be responsible for the excess heat and high temperatures at the electrode in the glow discharge experiments described in [1, 2]. The details will be presented in the conference.

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BIOGRAPHY

D. V. Chung: Ph.D. from The University of British Columbia in 1966, works at National Bureau of Standard for a one year before becoming a Professor at Howard University (1967-2006). Now retired and continues to work on experiments of CMNS.

Self-Polarisation of Fusion Diodes: From Excess Energy to Energy

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The cold fusion community has been trying to justify cold fusion on the basis of empirically produced excess heat for nearly two decades. The science world has continually resisted the possibility, citing the heat as not conclusive.

The authors have sought a different approach, whereby the device has no input energy, relying on the energy produced from the device. The diodes are fabricated as powder diodes, with a large surface junction made up of a semiconductor in contact with palladium charged with deuterium.

The suspected fusion reactions take place in the junction between the semi conductor and the Palladium powder, which produces an excitation which is transmitted to the electrons. This excitation increases their energy and allows them to cross the bandgap of the semiconductor and pass into the conduction band, as in a photovoltaic cell. This energy very quickly appears as a spontaneous potential difference which can reach over 0.5 volt per junction.

The potential drop concentrates on the junction region, and at a nano scale the electric field reaches considerable values, higher than the megavolt per meter, which constrains the deuterium nuclei and increases the probability of deuterium fusion.

Diodes comprising of a stack of junctions were made, making it possible to obtain over 1 volt at the poles of a very compact device of a few centimetres length. The released power remains very low for the moment, but it should be noted that it is presented in the form of directly usable electrical energy, and not of thermal energy.

The authors compare the density of energy obtained in their device, with the density of energy released by the first atomic pile produced by Fermi in Chicago. The levels of energy are very comparable to the fusion diode. The authors describe the various devices experimented with and used during this work over the last two years.

As well as this work, an extremely sensitive calorimetry device was built. The authors present the principle of this device, as well as a project for detecting of neutrons from very weak sources. This neutron counter records the particles emitted in all the directions of space, and can be scaled to the size of the neutron source.

Investigation of Deuteron-Deuteron Cold Fusion in a Cavity

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Through calculation, cold dd-fusion inside a cavity of solid is investigated. The mechanism of this process is neutron exchange in a weakened Coulomb field. There is attraction between two deuterons due to the exchange of neutrons [1]. Since the neutron is loosely bound in a deuteron and it is charge neutral this attraction has an effective range larger than that of nuclear force. While the exchange of electrons between two hydrogen atoms leads to a binding of hydrogen molecule, a bound state of two deuterons due to neutron exchange is not possible in vacuum due to the Coulomb repulsion. However, in a medium where the Coulomb field between the two deuterons is weakened a stable binding can be achieved. Such a medium was shown to be possible in a cavity of a solid [2].

Using all available information and experimental data in the calculation the following results were obtained:

- (1) The total potential (Coulomb plus neutron-exchange) between two deuterons could have a minimum if the Coulomb field is weakened to less than 50% of that in vacuum.
- (2) Following the suggestion in [2], the total Coulomb field between two deuterons trapped inside a cavity of a solid is taken to be a superposition of the repulsive field due to their positive charges and the field of a virtual anti-atom at the cavity. Calculation shows the end effect is like a overall weakened repulsive potential.
- (3) Because the weakened repulsive Coulomb potential dominates over the attractive neutron-exchange potential at large and very small deuteron-deuteron separation, a pair of deuterons trapped inside a cavity could via tunneling through a low barrier (maximum) end up in the shallow well (minimum) of the total potential. Then, via de-excitation it could fall into the depth of the well and becomes a stable pair at close range.

[1] C. M. Fou "Deuteron-Deuteron (dd) Binding via Neutron Exchange" *Infinite Energy*, vol 11, issue 66, 26-28 (2006)

[2] C. M. Fou "Coulomb Field for LENR in Solid" *Infinite Energy*, vol 12, issue 71, 25-27 (2007)

Cheng-ming Fou. Professor emeritus of University of Delaware. B.S 1956 National Taiwan University, Dipl.Phys. 1961 University of Munich, PhD 1965 University of Pennsylvania. Did research in theoretical and experimental nuclear physics, accelerator based atomic physics. Published more than sixty papers in refereed journals.

Open Source Science Applied to CMNS Research: A Paradigm for Enhancing Cold Fusion Prospects and the Public Interest

Thomas W. Grimshaw

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Open Source Science (OSSc) is a collaborative, voluntary (uncompensated) and highly distributed method of research that emphasizes the power of new digital technologies, particularly the Internet. The OSSc paradigm grew out of the open source software movement of the last 20 years, which has resulted in wide availability of free software (such as the Linux operating system) as an alternative to proprietary software products. In many respects, OSSc represents a return to the concept that scientific research results are a public good rather than a proprietary product – an attitude clearly articulated in the 1940s by Robert Merton, the “father” of the sociology of science.

The public interest in the success of cold fusion has long been tacitly accepted because of the potential social welfare benefits related to its possibilities for very low cost energy and even transmutation of chemical elements. Cold fusion researchers, because of rejection of their field by mainstream science and continued highly marginalized research conditions, already employ many of the methods and tools of OSSc. For example, they not only use websites for posting research papers and but also utilize Internet discussion groups for introducing ideas and dialoguing online about the merits and deficiencies of those ideas.

The prospects of cold fusion success may be significantly enhanced by extending the current informal and implicit use of OSSc-type methods to more organized and explicit deployment under the sponsorship of a recognized professional organization such as ISCMNS. A formal, sponsored use of OSSc for support of cold fusion could not only enhance current methods (not replace them) by bringing them under a professional organization “umbrella”, but also bring powerful OSSc methods into play that are not currently used. For example, research collaboration (especially by scientists in other fields) may be enhanced by establishing an open website dedicated to this purpose, including posting of research data (in addition to papers and interpreted information) by registered users. Another example would be a “wiki-like” website that would not only increase the availability and quality of cold fusion information, but also improve its accessibility to the public and policy makers, thus helping to “make the case” for badly needed public policy changes toward cold fusion. Fortunately, OSSc methods have been applied in other fields (e.g., environmental datasets), so working examples are well established and readily available.

The collaborative and voluntary approach of OSSc may be somewhat less powerful for highly technical and specialized fields (like the nuclear physics underpinnings of cold fusion theory and research) than has been the case for open source software, where the population of contributors is vast. Nevertheless, the prospects for cold fusion success, and the associated public interest in that success, would be significantly enhanced by expanded and more disciplined application of OSSc methods by the CMNS community.

Public Interest Arguments for Cold Fusion Policy Change: Opportunities for the CMNS Research Community

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It seems apparent that current public policy toward cold fusion in many countries, including the U.S., is no longer – and probably never has been – aligned with the public interest. Public policy makers, particularly elected officials, almost universally claim the public interest as the basis for policies that they develop or support. CMNS researchers must therefore recognize that current negative policies toward cold fusion can be reversed most effectively by making the case, and communicating it effectively to policy makers, of the evidence for cold fusion. The public interest will be well served by positive changes in cold fusion public policy.

CMNS researchers may not currently emphasize public policy toward cold fusion for two main reasons: 1) a greater interest, as scientists, in conducting experiments and developing theories than in the social process of gaining public or scientific acceptance; and 2) an implicit assumption that when sufficient scientific evidence – and reproducibility – are established, then the reality of cold fusion will “speak for itself”. It will then automatically gain acceptance – and favorable policies. The first factor is perhaps addressed by gently reminding researchers of something that they already know – it may be necessary to do more than good research to gain support, including research funding, for the investigations that they enjoy doing the most.

The second factor is more problematic, because the implicit assumption embraces the notion that public policy is generally rational rather than irrational – a natural assumption for scientists trained for (and practicing in) an environment where explanations of reality are grounded in rationality. Rational explanation of observations is at the core of the scientific method – and has been since the Enlightenment. Public policy that is based on rationality, on the other hand, is more the exception than the rule. Instead, much of public policy is set by ideologies, political factors, unspoken agendas and other non-rational drivers. The continuing negative public policy toward cold fusion since its initial rejection in 1989, despite the abundant and mounting evidence of its basis in reality since then, is perhaps a case study in non-rational policy making.

A resurgence has occurred in recent years for bringing rationality to the heart of policy development (“what makes sense” or, especially, “what works”) in the form of evidence-based policy making. This form of rational policy making has evolved out of evidence-based medicine, which has been found to be extremely effective in making decisions on best methods of medical practice. The central tenet of evidence-based policymaking is that the public interest is best served by what’s most rational and is best supported by the evidence.

Borrowing from the legal field, rational arguments can readily be made for at least a “preponderance of evidence” (greater than 50% probability) for the reality of cold fusion. And a case can even reasonably be made for “clear and convincing evidence” (probability over 70%) of its reality. Armed with such high levels of evidence, and arguing for a framework of evidence-based (rational) policy making, CMNS researchers can aggressively pursue changes in public policy toward cold fusion based on what’s best for the public interest.

Stimulation of Optical Phonons in Deuterated Palladium

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This work reports on progress made since 2007 in the triggering of excess power by terahertz stimulation of deuterated palladium. The stimulation was provided by tuning dual lasers to one of three specific beat frequencies corresponding to the known optical phonon frequencies of deuterated palladium (8, 15, 20 THz).

Results suggest that optical phonons may be involved in the Fleischmann-Pons effect, giving preliminary support to Hagelstein's phonon theory. The importance of laser beam polarization is also demonstrated, confirming earlier work reported by Violante *et al.* and by Letts and Cravens.



Dennis Letts has been working on electrochemical heat systems since 1990. He has built over 600 cells to study deuterium in palladium systems. He has pioneered the use of radio frequencies and lasers to trigger exothermic events in D-Pd electrochemical cells.

Survey of Recent Microscopic Ball Lightning Evidence in Transmutation Experiments

E. Lewis
Sciencejunk.org

In 1992[1], I proposed that microscopic ball lightning, a miniature version of macroscopic natural ball lightning, are produced in transmutation experiments and directly involved in the transmutation and anomalous results. Matsumoto was the first experimental researcher to accept this idea, as far as I know, and investigated the production of micro ball lightning in electrical discharge and electrolysis experiments associated with transmutation products. He also reported evidence of natural microscopic ball lightning emitted during two earthquakes in Japan. In the 1990s, Ken Shoulders reported the connection between objects he has called by several names (EVs, charged clusters, EVOs) and anomalous experimental results. These EVs are a type of ball lightning, leaving evidence and markings similar to that of micro ball lightning. Another name for these objects is plasmoids. Plasmoids were studied earlier by other researchers such as Bostick and Nardi. In 1996, I found markings that looked similar to plasmoid markings on the electrodes, the microspheres, and the clear Lexan plastic casing of the electrodes and microspheres of a transmutation experiment of Miley et al. that was named "Ni/Plastic Run #8." Pictures of some of these markings were published in several articles (for example, [2]).

During this decade, Savvatimova and Urutskoev et al. found many traces on x-ray films and nuclear emulsions around their transmutation experiments that are similar to those found earlier by Matsumoto on nuclear emulsions. Both of them carried on extensive investigation of these objects, and they and other scientists began experimental and theoretical research into the properties of the microscopic objects. Lockak and others say that the objects may be explained as Lochak monopoles. Priakhin et al. report that the "strange radiation" as they called it affected the health of mice after only a few days.

This paper is meant to be a survey of the research conducted during this decade. The earlier results of Bostick, Shoulders, Lewis and Matsumoto are discussed. Natural ball lightning exhibits behaviors similar to this microscopic ball lightning, and a few examples of these natural behaviors are discussed.

- [1] E. Lewis, "A Description of Phenomena According to My Theory and Experiments to Test It" manuscript article, 1992.
- [2] E. Lewis, "The Ball Lightning State in Cold Fusion," Proceedings of the ICCF10, Boston, 2003, World Scientific.

Edward Lewis also studies scientific revolutions and their relationship to economic depressions. The history of research on microscopic ball lightning, the current scientific revolution, and theoretical ramifications are discussed in another abstract submitted to this conference.

What Does the Eighty Year Periodicity of Paradigm Shifts in the History of Physics Suggest For the Development of the Cold Fusion Field?

E. Lewis
Sciencejunk.org

In the history of physics, paradigm shifts happened at about 80 year intervals; between about 73 and 87 years apart[1]. This happened because physics develops by the process of the scientific method, with theoretical formulation followed by the discovery of anomalies, followed by the formulation of novel general theory[1]. There have been 7 paradigms introduced since 1506. For each paradigm, a young or inexperienced person has formulated the basic premise of the general theory. Then, other theoreticians of the following generation have well developed the theory of the paradigm by the time they are in their middle age. Then, technicians and inventors in the following generation, when they are middle-aged, used the developed general theory and its accurate, mathematically described predictions to discern important anomalies. Inhibition of apprehension of anomalous phenomena permits only the young or inexperienced to formulate the basic premise for general theories. The difference between theoreticians, and experimenters and technicians has caused both the fundamental testing of a general theory leading to the discovery of anomalies and the invention of revolutionary products leading to the development of most of the paradigm's industry to happen only during the third generation. During these "crisis periods" of the discovery of important anomalies, two kinds of general theories have emerged during the prior 6 scientific revolutions. One kind was a reformulation of the standard theory of the generally accepted paradigm. The other kind, introduced by a young or inexperienced person, was revolutionary.

Based on this theory, we can predict that two kinds of theories for transmutation and plasmoid phenomena will emerge. One will be based on a modification of the Quantum-Mechanical and Relativity paradigm to explain anomalies, and the other kind will be based on novel hypotheses. It is also predicted that most of the industry of this new paradigm will be produced by a third generation of technicians and inventors well into the future, if the new paradigm theory is accepted by younger people who develop the theory, God willing.

This paper attempts to describe the discovery of the major anomalies that may lead to the development of a new paradigm for physics: transmutation phenomena, the discovery of an active state of matter and energy associated with ball lightning, the plasmoid nature of the discernable universe, superconductivity, and other anomalies.

[1] E. Lewis, "The Periodic Production of Rationalized Phenomena and the Past Periodic Depressions," manuscript article, 1990.

Edward Lewis sent another abstract to this conference about evidence of microscopic ball lighting in the experiments of a number of transmutation researchers. The markings on electrodes and detectors that people are finding in this decade are similar to those found earlier by Shoulders, Matsumoto, Lewis, Bostick and others, and the emitted objects behave like natural macroscopic ball lightning.

Combustible Substances Showing Organic Properties from Water

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Some combustible substances showing organic properties (CSSOP) have been found in the reaction system during electrolyzing water with the addition of proper catalysts. The catalysts used in this study were transition metal complex that exhibits functions of reaction center in photosynthesis. The CSSOP is originated from two possible areas: H₂O was split into H₂C: and ⁴He, and/or H₂O was separated into isoelectronic species of H₂C: and electrons, where both H₂C: and isoelectronic species of H₂C: are chemical reactive species, the building blocks of the CSSOP, that can be linked to form the CSSOP. The experimental evidence is favorable for the chemical origins of the CSSOP. Under both circumstances, the main body changed in the processes is oxygen in water rather than hydrogen, therefore, the CSSOP is also called oxygen fuel [1].

It will release heat energy when building blocks of the CSSOP undergo wet oxidation in the course of reactions, drawing a conclusion that this is the real sources of the excess energy produced from all of aqueous electrochemical experiments, at least in large part if not all. Based on the fact of the CSSOP generation, we can predict that the signals of carbon atoms are bound to be detected in a twinkling provided there exists excess heat in electrolyzing system of water (H₂O and/or D₂O); and the CSSOP can be generated only when no reaction heat is released and proper catalysts are existed. On the basis of the principle of chemistry that the precise arrangement of the links (bonds) determines chemical properties [2], the chemical energy stored in the CSSOP is attributed to the rearrangement of constituent atoms in water to form similar bonding scheme with hydrocarbon. The most prominent property of the CSSOP is its combustibility, which implies that the CSSOP can be used as clean fuel. Another important property of the CSSOP is its nonpolarity, suggesting that this technology can be used for treatment of waste water and desalination of seawater.

- [1] F. Liu, "An Attractive Strategy for Solar Energy Conversion: an Oxygen Fuel from Water", ISES Solar World Congress 2007, Beijing, Vol. V, pages 2795-2798, (2007).
- [2] R. Breslow, "Chemistry Today and Tomorrow", American Chemical Society, pages 6-7, (1997).

Professor Fu Liu graduated from Chemical Engineering Department of Tianjin University in 1963. He taught polymer chemistry at Hebei University of Science and Technology and environment chemistry at Environmental Management College of China. At the University of Pittsburgh, Brigham Young University, Stanford University, and University of California at Davis, he conducted research on catalysis for high alcohols, Fischer-Tropsch Synthesis, super acid, and water chemistry. Professor Liu has focused attention on experimental and theoretical work of water-based energy sources since 1986.

The Phusor™ LANR Cathode is a Metamaterial which Creates Deuteron Flux for Excess Power Gain

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JET Energy, Inc., Wellesley, MA

We have analyzed why the Phusor™ type LANR (lattice assisted nuclear reaction) device, with its helical, cathodic design and low electrical conductivity solution into which it is immersed, is the most successful half-electrochemical system we have found for LANR. This is judged by excess heat production, robustness, and other engineering factors. We report that the Phusor™ LANR device is a metamaterial that demonstrates LANR properties not previously observed or expected. Furthermore, the metamaterial properties enhance the metallurgic properties of the loaded palladium. It is the Phusor™ LANR device's stereoconstellation which invokes a metamaterial change of the electric field distribution, which then produces deuteron flux within the loaded metallic palladium - even at equilibrium. Thus, Phusor™ LANR device metastructure creates a unique, distinguishing electric field distribution quite different from customary wire-wire and plate-plate systems (Figure 1).

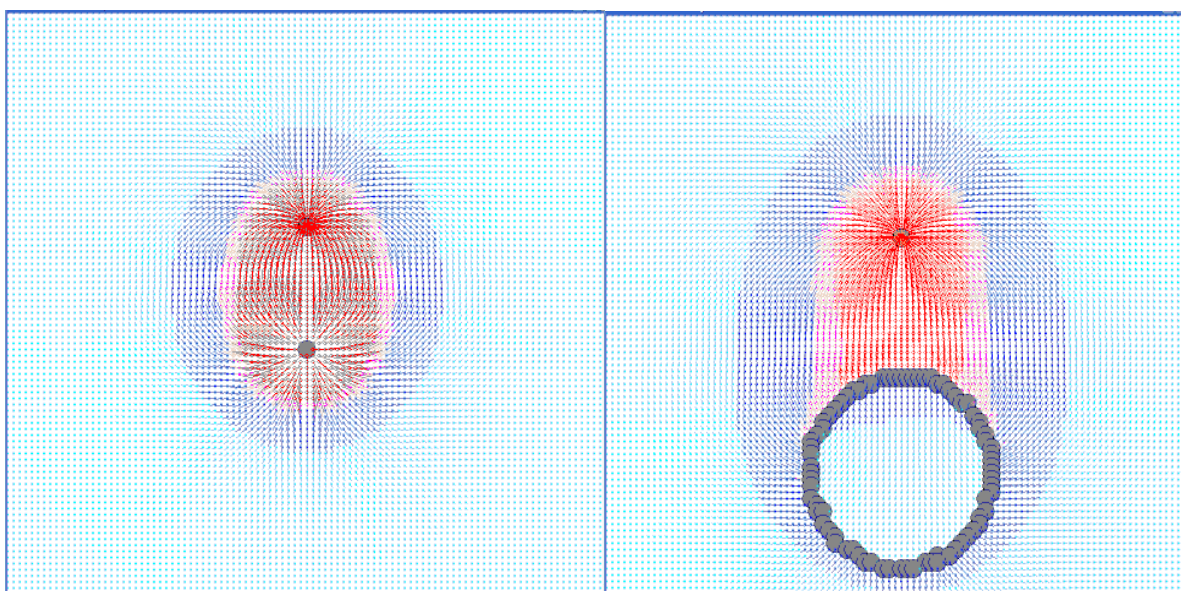


Figure 1 - 2-Dimensional Vector Electric field Distributions Show Metamaterial Nature
 (left) 2-D vector E-field distribution for two parallel, infinitely long, electrodes wire electrodes (anode at the top, and cathode wire).

(right) 2-D vector E-field distribution for the wire-Phusor™ LANR system

1. M. Swartz, G. Verner, "Metamaterial Production of Non-equilibrium Deuteron Flux In A Palladium Cathode", submitted (2008).
2. D.R. Smith, J.Pendry, M.Wiltshire, "Metamaterials and Negative Refractive Index", Science (2004)

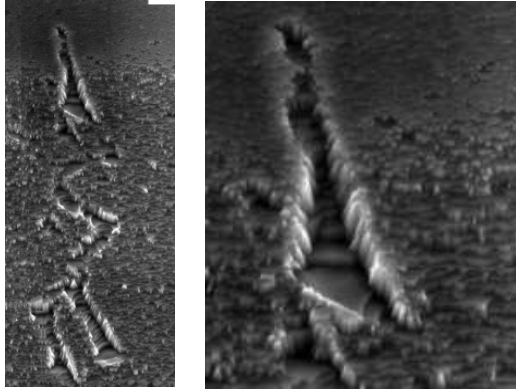
The Mechanism of Creation of Magnetic Monopoles in Strong Magnetic Field of Laboratory System

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² *Kiev Shevchenko National University, Faculty of Radiophysics, Kiev, Ukraine*

In our earlier work [1] we have presented the results of interaction of unknown magnetic-charge particles (magnetic monopoles) with surface of MDS structure - the traces of ordered thermo-



mechanical impact on the surfaces. These results were observed during experiments at Kiev Electrodynamics Laboratory "Proton-21" on achieving the superdense state of the matter by using the high-current electron driver. It was shown that the source of a great specific energy release, $dQ_{tot}/dl \approx -10^6$ GeV/cm, spent on the formation of these traces, is the processes of nuclear synthesis reactions $Al^{27}+C^{12} = K^{39}$, $Al^{27}+C^{13} = K^{40}$, which are running with the participation of MDS-structure surface nuclei and are stimulated by magnetic monopoles.

In the present work the parameters of these monopoles and the mechanisms of their creation in Earth laboratory are discussed and calculated. Detailed analysis of experimental data and isotope distribution in the area of monopole reflection from local FeCo micro magnet on a MDS surface (see Fig.) has shown that the upper limit of magnetic monopole mass is less than $m_g=10^{-22}$ gram, that is by 10^{15} times less than previous well known cosmological estimations (10^{-7} gram)! So, the unknown particle may be a light magnetic monopole, that was introduced by George Lochak and that is the neutrino in magnetic excited state.

There are two ways of generation of such particles during experiments in our laboratory:

1. Creation of these monopoles during nuclear processes of protonization and neutronization in collapse zone with the presence of very strong squeezed nonuniform magnetic field.
2. Generation of these monopoles during break of stable monopole-antimonopole pair of cosmological nature in very strong squeezed magnetic field in experimental setup.

We have calculated the size of this pair $r_0 \approx g^2 / 2m_g c^2 \approx 10^{-10} - 10^{-13}$ cm, the ratio of kinetic and potential monopole energy $\{T/V\}_{r_0} \approx (\hbar c / 2g^2)^2 \ll 1$ inside the stable pair and the probability of tunnel decay of this pair at action of self-compressed magnetic field frozen in the superdense plasma in experimental setup during collapse.

Small ration and high binding energy show that in non-excited state monopole-antimonopole pair is very stable. Such pair is uncharged, has very small both size and total mass $M_{g\bar{g}} \ll m_g$ and is, in fact, invisible micro object.

[1] S. V. Adamenko, V. I. Vysotskii //12th CMNS Proceedings, Japan, pp. 356-366.

Roles of Finite Size and Interfaces in Nanometer-scale PdD and Composite Compounds Containing Pd, D, and ZrO₂ in the Pons-Fleischmann Effect

Scott R. Chubb

Infinite Energy Magazine, 5023 N. 38th St., Arlington, VA 22207

New effects involving finite, approximately ordered (nanometer-scale) crystals, containing PdD_x, are identified in the high-loading limit, defined by $x = 1 \pm |\delta|$, with $|\delta| \ll 0.002$. Consistent with the strong, anti-bonding characteristics of the electronic energy band states immediately above and below the Fermi energy in PdD, when D is loaded into pure nanometer-scale PdD crystals, the associated effects result from transient, ionic fluctuations, in which small ($\sim|\delta|$) variations in loading lead effectively to a situation in which each nucleus (each deuteron-d) of each deuterium (D) atom dissociates from its electron and is allowed to interact with other d's coherently that are involved with the fluctuation, by occupying (or through interactions involving) ion band states. When a nanometer-scale size insulating material (such as ZrO₂) is included during the loading process, it is expected that composite compounds (ZrO₂/D_z/Pd, ZrO₂/D_z/PdD_x, and/or ZrO₂/PdD_x) will form. Depending on the loading conditions, the model associated with the initiation of Pons-Fleischmann Excess Heat (PFEH) involving ion band state interaction, in PdD_{1±|δ|} (in which heat is produced through a $d + d \rightarrow {}^4\text{He}$ reaction), can still apply provided two important features of the associated dynamics are satisfied: 1. 1-, 2-, or 3- dimensional periodic order is required in some finite domain within a portion of the composite that contains a Pd or PdD host; and 2. The associated fluctuations involve an effective form of dissociation (between each d and its electron). The important dynamical constraint that dictates if appropriate forms of dissociation occur involves the behavior of the electronic energy band states in the immediate vicinity of the Fermi energy. When these states are anti-bonding (relative to the d-nuclei), ion band state interaction can become important, and the earlier model can apply. From this starting point, using a recently developed theory that formally justifies conventional energy band theory (as it applies to electrons and/or ions that interact with a periodic potential in finite lattices), an argument is presented that generalizes the concept of tunneling developed by Zener. Using this argument and known facts about PFEH, arguments, leading to optimal crystal sizes (~ 10 's of nanometers) for triggering excess heat, are presented, as well as estimates of the required triggering times, it is argued that anti-bonding characteristics in the behavior of the electrons in the immediate vicinity of the Fermi energy are required to initiate PFEH, and detailed studies of the electronic structure of the associated states in the various composite (ZrO₂/D_z/Pd, ZrO₂/D_z/PdD_x, and/or ZrO₂/PdD_x) compounds are needed to understand the relevant dynamics.



Scott Chubb has been employed as a research physicist at the Naval Research Laboratory (NRL) since 1989. Prior to joining NRL, he worked there as a contractor for SFA, Inc (between 1988 and 1989), and as a National Research Council fellow (between 1985 and 1988). He began his career as a research associate at Northwestern University, where he worked between 1982 and 1985. An author of more than 60 technical papers, he has been an editor of numerous Cold Fusion publications and participated in the 10 year study, sponsored by the Office of Naval Research, that documented the existence of PFEH.

Interface Model of Cold Fusion

Talbot A. Chubb

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The Arata and Zhang (A-Z) cold fusion (solid fusion) heater demonstration on 22 May replaces classical collision fusion with a solid state physics catalytic process which depends on new materials [1]. These materials are ionic oxide + nanometal composites, and enable the special properties of nanometals to be used in practical applications. They were developed at the Institute for Materials Research at Tohoku University, and are not yet commercially available [2]. The A-Z dd fusion process is modeled as an outgrowth of earlier work using Pd black, in combination with insights gained from work by Iwamura et al. at Mitsubishi Heavy Industries [3]. The A-Z technology seems destined to provide reliable cold fusion heat without the need for the "purity and perfection" required for cold fusion heat generation in bulk metal.

A-Z (1994) modeled dd cold fusion as due to "Spillover Deuterium." Iwamura et al. showed that D flow through Pd metal containing CaO produced heat at $D/Pd < 1$. The composites solved a crystal growth problem in Pd-black. The new gas loading work shows that $ZrO_2 + nanoPd$ composite can produce cold fusion heat without the complexity of permeation flow, provided slightly elevated temperature and high D_2 pressure are provided. A-Z (2002) showed higher heat production when D permeation flow is present. The interface model of cold fusion argues that an epitaxy interface between a highly negative free energy ionic crystal and a matching layer of transition metal can host many-body D^+ ion band state material in a layer characterized by stable 2-dimensional lattice symmetry and a thickness much less than that of a normal metal layer [4]. Theory argues that a transition from a spin-zero many-body pairing to a 2-body pair leads to a collapse of the D^+ material. Subsequently, changes in the internal nuclear geometry structure between pn,nn pairing and pp,nn pairing occur. The nuclear transitions are $0+$ to $0+$ transitions, and coupling to the metal lattice is aided by momentum shocks produced by additions and subtractions of deuterons to the D^+ many-body population. Shocks occur when permeation flow delivers and removes deuterons from the many-body population. The accompanying electrons that maintain charge neutrality thicken and thin the D^+ reactive layer, creating momentum shocks which stimulate sequential energy transfers to the hosting interface metal.

- [1] Y. Arata and Y-C Zhang, *Proc. Japan Acad.*, **70B**, 106-111 (1994), *Proc. Japan Acad.*, **78B**, 57-64, (2002); *Proc. ICCF12*, ?, (2007); *J. High Temp. Soc. Jpn.* **Feb/March Issue**, (2008).
- [2] S. Yamaura, K. Sasamori, H. Kimura, A. Inoue, Y. C. Zhang, Y. Arata, *J. Mater. Res.* **17**, 1329-1334, (2002).
- [3] Y. Iwamura, T. Itoh, N. Gotoh, M. Sakano, I. Toyoda, and H. Sakano, *Proc. ICCF7*, 167-171, (1998).
- [4] G. Barcaro, A. Fortunelli, G. Rossi, F. Nita, and R. Ferrando, *Phys. Rev. Lett.* **98**, 156101: 1-4, (2007).

Talbot A. Chubb, AB Physics Princeton, PhD Physics U. North Carolina, Naval Research Lab. retired, Fellow APS & AGU, Member AAS, Navy Distinguished Civilian Service Award.

Quantum Fusion Hypothesis

Robert E. Godes
Profusion Energy

There is no respect for the field of cold fusion because it is not “fusion” as the current establishment defines it. This community is not helping things by claiming “Cold Fusion” is DD fusion. The Pons Fleischmann reaction starts with deuterium and ends with helium. This would seem to indicate DD fusion, but is similar to the following story.

Some researchers trained frogs to jump when they clapped. They decided to see how cutting off legs affected the frogs’ ability to jump. They carefully measured how far the frogs jumped, then how far they jumped after cutting off one leg, then two legs. It did not seem to matter that they were cutting off the frogs’ legs, when the frogs heard them clap they tried to jump. However the researchers noted that cutting off all four legs seemed to make the frogs go deaf!

Robert Godes designed, built, and has patent applications on methods to drive the confinement of individual hydrogen nuclei within the octahedral points of the lattice.

In a Bose-Einstein condensate, super-cold atoms have a very small Δp . To satisfy $\Delta p \Delta q \geq h / 4\pi$ (Heisenberg Uncertainty Principle), a very large Δq occurs and if the atoms follow Bose statistics, a Bose-Einstein condensate is formed. To reliably control the PF reaction, one must supply what the patent application describes as Heisenberg Confinement Energy. This causes a very large Δp (energy) by forcing a very small Δq . When the energy achieves or exceeds 782KeV, the hydrogen nuclei undergo an electron capture event as a natural energy reduction mechanism. This highly endothermic reaction results in cold to ultra-cold neutrons and/or neutron clusters. The neutrons interact with other hydrogen nuclei moving through the lattice resulting in ^4H . Part of the problem for established physics is that National Nuclear Data Center (NNDC) has defined the ground state of a nucleon as the lowest energy at which it has been observed. For ^4H that would be $\sim 10^{-25}$ seconds after an 8MeV neutron collides with Li. In a metallic lattice where low energy neutrons accumulate, β^- is the decay path. NNDC indicates this but only if you dig for the information. To retrieve this data, go to <http://www.nndc.bnl.gov/ensdf/>, enter 4H in the Quick search: box, and click “Search”. Click the check the box next to the ^4H and click “HTML”. Please read the first sentence in the data sheet. According to Dr. Kelly, if there were some way to make 4H at a low enough energy (≤ 3.53 MeV), then it would undergo β^- decay. That can’t be done in an accelerator and all NNDC information on 4H originated from accelerator experiments. When solid-state systems produce excess heat and ^4He , each helium nucleus formed liberates between 23.2MeV and 27.5MeV depending on the exact path taken.

Robert E. Godes obtained his BSEE in 1988. After hearing about the PF fiasco and the properties of Pd in 1992, the factors that drove the reaction seemed clear to him. He initiated more intensive studies of material science, quantum mechanics, and methods to exploit the properties of materials like Pd. Presently prototype reactor control systems have successfully run the reaction with 100% reproducibility, good power control, and instant startup. The controls run with Ni 270 or Pd 99.9% in light water.

Work Program for Developing Technologies in Environmentally Safe Alternative Energy Engineering

I. Goryachev

*Research Director, Institute of High Technologies
Russian Research Center "Kurchatov Institute"*

Today it is evident that traditional energy carriers are exhausting and getting more expensive. It arouses great interest towards searching for and developing new highly effective environmentally clean sources of energy. The expensive projects being developed at present which are aimed at global solving energy problem will hardly be capable in the nearest future to be practically realized. For instance, the ITER Program of creating a thermo fusion reactor stipulates creation of a demonstration facility by 2026 and a workable model – by 2060. But the huge amount of both physical and technical problems related allows to doubt in reality of the schedule mentioned. The projects of implementing solar converters being developed during several last decades as well as those related to likely use of wind or tidal energy would hardly influence significantly solution of energy problems.

Meanwhile one of the most perspective way in searching for solution of that problem seems to be developing generators which are based on implementing phenomena connected with anomalous energy balance. Such phenomena were continuously observed by scientists all through the XXth century and during last 60-70 years in particular both in Russia and abroad. Of late in several countries even more scientists get involved in the works on developing and designing units with anomalous energy balance. Various energy generating systems and units are reported to have been created in USA, Switzerland, Australia, England, Japan and in some other countries. Such information embraces wide publications in scientific journals, and also patents in several classes of energy generating installations. Russian scientists take active part in developing the problems of alternative energy engineering, though this direction of R&D has not got official support so far. The results obtained in the course of those investigations made it possible to put on the agenda creating energy generating installations of practical implementation. No doubt that these works would result in development of technologies of alternative energy in the nearest years provided the appropriate funding is available. These technologies will definitely determine the shapes of future energy engineering.

The Program Goals includes creating within the period of 1.5 to 5 years a series of experimental and pilot energy generating units with output power ranging from decades of kilowatts to hundreds of megawatts electrical or thermal and carrying on R&D works to create basis for perspective projects of designing innovative energy generating units. The Program presented displays seven projects including the main cost/time parameters and technical characteristics of the power units. It also contains some schematics and pictures of experimental set ups.

Prospective Way to Solve the Problem of Radioactive Waste

I. Goryachev ¹, V. Kuznetsov ²

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² *Dubna Center of Applied Physical Research, Director*

At present intensive investigations are being carried on in many countries with a view to developing effective methods of treating radioactive waste (RW). In most cases those works are aimed at providing isolation of RW from environment and long term safe storing RW of different origination. One of the directions of developing such technologies with application to low and intermediate level RW stipulated significant decreasing of the waste initial volume and converting it into a form suitable for disposing it of for a long term storage.

It is recognized now by many specialists that the most perspective technology for solving this problem is the technology of plasma pyrolysis of the organic components and melting inorganic part of RW and converting it into the form of vitrified slag. Provided the appropriate technical solution implemented the technology stipulates incorporating (capturing) 90-95% of the entire radioactivity of the waste material inside the vitrified slag as well as actual absence of dangerous discharging of radioactive and other hazardous products into the atmosphere.

Such technology has been developed in Russian Research Center “Kurchatov Institute” and realized in Russia in cooperation with Scientific and Industrial Association “Radon” at two pilot facilities – installations “Pyrolysis” and “Pluton” – and at present, based on those two installations, a number of new facilities of higher capacity for processing RW at nuclear power plants and processing waste of different originations. It is worth to note that these Russian facilities obtain a number of significant advantages as compared to other known installations implementing analogous technological principles, in particular, the “PACT” installations developed and manufactured by the “Retech” US company.

Meanwhile, thanks to the success in research of low energy transmutation of nuclei of chemical elements, now there has appeared a possibility of solving the problem of utter remediation of RW. The results of experimental and theoretical research of Russian scientists [1] allow us to hope that the newly discovered method of electromagnetic impact on radioactive materials that results in transforming unstable isotopes into stable ones and such process is not accompanied with any ionizing irradiation. It was determined that low energy transmutation is actually a threshold nuclear reaction of resonance nature and of exothermic type which makes it energetically advantageous. According to their findings in order to initiate reaction of transmutation radioactive material is placed into special reactor and subjected to irradiation with electro-magnetic energy of specific frequency, amplitude and topology. The authors of that discovery determined that the process of transmutational processing RW may take from decades of minutes to several hours depending on the isotopic composition of radioactive compound and its concentration.

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Complexity in the Cold Fusion Phenomenon

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The cold fusion phenomenon (CFP) in Solid-State Nuclear Physics or Condensed Matter Nuclear Science occurs in composite systems with regular arrangements of host nuclei (C, Ti, Ni, Pd, etc.) and hydrogen isotopes (H, D). We have figured out several features of experimental data sets in the CFP showing characteristics of many-particle effects such as (1) the inverse-power law of excess power generation [1], (2) the stability effect of transmuted product nuclei (elements) [2], and (3) bifurcation of intensity of effects [3]. The systems (CF materials) where occurs the CFP have common properties with those where observed complexity experimentally which has also been investigated theoretically with computer simulation. We have microscopically analyzed CF materials to find out causes of events [1, 2] resulting in the above-mentioned many-particle effects and explained the occurrence of the complexity in the CFP [3, 4].

In our analyses, it was shown that the adjustable parameter n_n appeared in the TNCF model which has been successful to give several quantitative relations between numbers of reactions N_x for events X in accordance with experimental data sets seems to be useful as a parameter governing the equation describing dynamical processes resulting in complexity. Classical experimental data sets such as those by Fleischmann *et al.* (1989), De Ninno *et al.* (1989), and McKubre *et al.* (1993) have revived as typical examples showing some phases of the CFP related with complexity.

Thus, the controversial questions such as reproducibility and controllability of events in the CFP used to denounce its reality are resolved by its nature as pointless and nonsense. Possible promising applications of the CFP will be realized effectively on the bases of scientific understanding of the phenomenon.

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Nuclear Transmutations in Polyethylene (XLPE) Films and Water Tree Generation in Them

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An explanation of the nuclear transmutation (NT) observed in the XLPE (crosslinked polyethylene) films dipped in aqueous (light and heavy water) electrolytic solutions with and without application of high-frequency electric field [1 – 3] was presented by the neutron-drop model used in the theoretical investigation of the cold fusion phenomenon in transition-metal hydrides/deuterides (CF materials) [4].

The NT's $K \rightarrow Ca$, $Mg \rightarrow Al$, $^{56}_{26}Fe \rightarrow ^{57}_{26}Fe$ and $Fe \rightarrow Ni$ are explained by a single neutron absorption with or without a succeeding beta-decay to get final nuclides. The NT's $^{56}_{26}Fe \rightarrow ^{64}_{30}Zn$ and $^{56}_{26}Fe \rightarrow ^{60}_{28}Ni$ are explained by an absorption of a neutron drop $^8_4\Delta$ and $^4_2\Delta$, respectively, in the cf-matter that was supposed to be formed at boundary regions of crystallites in the sample. Production of wonderful elements Li, Pb and Bi is discussed from our point of view.

Thus, we concluded that the generation of water trees in XLPE samples is caused by nuclear reactions induced by cold fusion phenomenon at around spherulites a mechanism of which may be explained by the neutron-drop model proposed by one of us (H.K.) already. The NT found in XLPE may have direct relation with the NT's found in biological systems (biotransmutations)[5].

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Predictions of the Extended Micro Hot Fusion Scenario

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Steven Jones et al. reported to have observed neutron emissions from heavy water electrolysis cells [1]. Critics suggested that the neutrons resulted from fluctuations of the secondary neutron component of the cosmic radiation, cosmic ray muon catalyzed fusion, photodisintegrated deuterons, statistical and systematical biases, or solar flare neutrons [2]. I argued that the neutron emissions can hardly be explained by background effects but by the extended micro hot fusion scenario [3]. Here I will show that the extended micro hot fusion scenario predicts that neutron emissions can be observed with high reproducibility if the electrodes are not predeuterided, the measurements start with electrolysis, and the electrolysis time does not last longer than several hours.

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Controlled thermonuclear fusion of hydrogen nuclei during sodium metal dissolution in aqueous Epsom solution at a critical salt concentration through cavitation induced metastable nanocrystal nucleation – Can water serve as an infinite source of energy?

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A coherent mechanism consistent with basic scientific principles but the one which differs considerably with that supported by conventional chemists is proposed to explain the process of peaceful sodium metal dissolution in concentrated ($\sim 2\text{M}$) aqueous Epsom solution. Our proposal is based on cavitation induced meta stable nucleation of micro- and nano- Epsom crystals in aqueous solution undergoing vortex rotation. Thermodynamic activity of H_2O is reduced due to continuous solvation process of these crystals which reduces the $\text{Na-H}_2\text{O}$ reaction rate considerably. Na atoms hence get incorporated in the MgSO_4 crystalloids formed due to cavitation by Na-Mg exchange reaction (i.e., $2\text{Na}^0 \leftrightarrow \text{Mg}^{2+}\text{SO}_4^{2-} \rightarrow \text{Mg}^0 + \text{Na}_2\text{SO}_4$) and the Mg^0 atoms released react with water to produce $\text{Mg}(\text{OH})_2$. The intense explosion accompanied with a shock wave and vaporization of glass beaker containing salt solution witnessed in 0.85 M Epsom solution on the completion of sodium dissolution is, however, explained on the basis of nuclear fusion of hydrogen nuclei trapped in cavitation induced nano-crystals at Mg^{2+} lattice sites.

The trapping of hydrogen ions in cavitation induced crystals is invoked to explain the energy release. Water molecule (positioned in SO_4^{2-} vacancy site) together with two hydrogen ions (H_2^{2+} species positioned at Mg^{2+} site) form the species H_4O^{2+} , known as protonated hydronium dication. The electrostatic force of repulsion between the two hydrogen ions would however prevent them to come together thereby making the crystalloid a highly unstable structure. It would hence tend to break the moment it is formed. However, cavitation will reform these crystalloids and thus an oscillatory reaction sets in. But, the collapse/dissolution of the above nano-crystals in water would release a considerable amount of energy due to the hydration of ions. As a result, the temperature and pressure will increase asymptotically and the crystal in nano state will be eventually formed when the former force (lattice energy) ably assisted by the localized heat energy made available due to repeated hydration process overcomes the latter force (electrostatic repulsion of hydrogen nuclei). The formation of such a nanocrystal is possible only when both the hydrogen ions fuse together so that they occupy a Mg^{2+} ion site. This is the basic but simple and elegant mechanism of ionic crystal lattice assisted nuclear fusion proposed.

Enhanced Cluster Reactions in LENR

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Swimming Electron Layer (SEL) theory resulting in heavy “complex nuclei” was proposed earlier to explain the nuclear reaction products observed in the “Patterson” flowing packed bed type electrolytic cell experiments that used multi-layer thin films of metals on mm-size plastic beads. [1] More recently a modified cluster model has been developed to further explain these and related transmutation experiments. [2-4] As found in the original experiments and later thin film studies, excess heat was also obtained in these experiments [5], and the cluster theory also predicts that. This model is also reasonably consistent with associated measurements of energetic charged-particle emission during thin-film electrolysis and certain aspects of localized reactions and X-ray production during plasma bombardment experiments. This cluster reaction model and supporting data will be discussed in detail.

As a result of this added understanding of cluster reactions, a new class of electrodes is under development at the University of Illinois. These electrodes are designed to enhance cluster formation and subsequent reactions. The basis of these electrodes originates from earlier studies of superconductive states formed in dislocation loops formed in cyclic loading-unloading of H/D thin-film palladium electrodes. Two approaches are under development. The first employs improved loading-unloading techniques intended to obtain a higher volumetric density of sites favoring cluster formation. This includes added pretreatment of the electrodes plus extended cyclic operation and modified annealing procedures. The second type of electrode is designed to create nano-structures on the electrode where the cluster state is formed. Palladium is deposited on a nickel foam substrate using an electrodeless deposition technique. Then, after chemical treatments, destabilized palladium then plates the foam substrate. Further details about these electrodes along with preliminary test results will be presented.

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Transmutation of Elements during Conditions of Low-Energy Glow Discharge Exposure and the Associated Processes

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Results of the analysis of numerous glow discharge (GD) experiments during and after irradiation by GD ions, from 1989 to 2008, are presented. This review includes the structural, elemental, and isotopic changes of materials caused by irradiation of the cathode with low-energy ions. The dependence of these changes on the parameters of the GD process (type of ion, current, and frequency, etc.) is described.

Measurements of the gamma emission intensity outside of the GD chamber were made, both during an irradiation by ions and after de-energizing the GD, are given.

Changes of intensity of emission of alpha, beta, and gamma radiation from natural uranium due to GD bombardment with ions of hydrogen and deuterium, and also changes of isotopic abundance are presented.

Emission of charged particles, registered on the cathode after GD de-energizing, and their dependence on process parameters are described.

Excess heat results obtained during deuterium bombardment of cathodes are included.

This complex of analyzed results is thought to be good probative evidence of the stimulation of nuclear processes by low energy ions during GD.

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