The 10th Meeting of Japan CF-Research Society

JCF10 ABSTRACTS

March 5-6, 2010

Hachioji, Tokyo

Japan CF-Research Society

Program of JCF10 Meeting

(Japan CF-Research Society)

Date: March 05-06, 2010

Place: The 11 and 12F of Hachioji-Tokyu-Square-Building, (Tel.:042-646-5611, Fax: 042-646-2663), 9-1, Asahimachi, Hachioji, Tokyo, 192-0083, Japan

Paper presentation: Oral presentation 20 min. + Discussion 5 min.

Language= English or Japanese

Book of Abstract: Only available at JCF home page;

http://dragon.elc.iwate-u.ac.jp/jcf/index.html

March 05 (Fri.), 2010 (at Seminar Room no.1)

12:00-13:00 **Registration**

13:00-13:10 **Opening Address** (K. Tsuchiya, N. C. T.)

Experiment-1 (Chairman: E. Yamaguchi, Doshisha U.)

13:10-13:35 **JCF10-1** T. Hioki et al. (Toyota Central R & D Labs.): Hydrogen/Deuterium Absorption Capacity of Pd Nanomaterials and Its Relation with Heat Generated upon Loading of Hydrogen Isotope Gases

13:35-14:00 **JCF10-2** Y. Toriyabe et al. (Tohoku U.): D + D Fusion Acceleration in High Temperature Acoustic Cavitations

14:00-14:25 **JCF10-3** Y. Sasaki et al. (Kobe U.): Measurements of Heat and Radiation from Pd Nano-powders during Absorption of Hydrogen Isotopes

14:25-14:50 **JCF10-4** Y. Miyoshi et al. (Kobe U.): Two Absorption/adsorption Processes of Hydrogen Isotopes Observed for Pd Nano-powders

-----**break** (15 min)-----

Theory-1 (Chairman: M. Fukuhara, Tohoku U.)

15:05-15:30 **JCF10-5** A. Takahashi (Technova Inc.) et al. : Role of PdO Surface-Coating of Pd Nano-Particle for D(H) Charging and Cluster Fusion

15:30-15:55 **JCF10-6** M. Ban (Tokyo Metropolitan Leather Technology Center) et al. : A Power Spectrum Change by Irregular Periodicity of Superlattice at Tunnel Resonance of CF

15:55-16:20 **JCF10-7** K. Tsuchiya et al. (Tokyo T. N. C. T.): A Theoretical Study on the Possible Change of the Phonon Dispersion Relation due to the Nuclear Reaction in Solid Ⅱ

16:20-17:00 **JCF Annual Meeting**

17:30-19:30 **Reception**

March 06 (Sat.), 2010 (at Seminar Room no.1)

Theory-2 (Chairman: K. Tsuchiya, T. N. C. T.)

10:00-10:25 **JCF10-8** N. D. Cook (Kansai U.) et al. : Simulation of Uranium and Palladium Fission Products Using a Lattice Model

10:25-10:50 **JCF10-9** H. Numata (Tokyo Institute of Tech.) et al. : Cellular Automata Numerical Simulation of Cascade Vortices

10:50-11:15 **JCF10-10** S. Sasabe (Tokyo Metropolitan U.) et al. : Abraham-Lorentz-Dirac Equation in Quantum Mechanics: The Beginning of Weakened Coulomb Potential

11:15-11:40 **JCF10-11** H. Miura : Computer Simulation of States of Hydrogen in Metals of Face Centered Cubic Lattice

-----**lunch** (11:40-13:00)-----

Experiment-2 (Chairman: A. Kitamura, Kobe U.) (at Seminar Room no.2)

13:00-13:25 **JCF10-12** Y. Toriyabe et al. (Tohoku U.): Charged Particle Detection during Gas Loading/Permeation Experiment with △E – E Si Counter Telescope

13:25-13:50 **JCF10-13** H. Sasaki et al. (Iwate U.) : Search for Nuclear Events in Deuterium Discharge Experiment Using Multi-layered Metal Cathode

13:50-14:15 **JCF10-14** S. Narita et al. (Iwate U.): Anomalous Tracks Recorded on CR-39 in Deuterium Desorption Experiment

14:15-14:40 **JCF10-15** H. Yamada et al. (Iwate U.): Detection of Energetic Charged Particle from Thin Ni Cathode in Shortened Li_2SO_4/ H_2O Electrolysis Using Track Detector CR-39

-----break (15 min)-----

14:55-15 :55 **Round-table Discussion on Experiment**
(Chairman: H. Yamada, Iwate U.)

Adjourn

Hydrogen/deuterium absorption capacity of Pd nanomaterials and its relation with heat generated upon loading of hydrogen isotope gases

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It has recently been reported by Arata and Zhang that by simply loading nanocomposites of Pd/ZrO2 or Pd/Ni/ZrO2 with deuterium gas, they have observed a heat generated from D-D nuclear fusion reaction [1]. The D-D nuclear reaction has been suggested from the observation of a remarkable increase of ^{4}He in the gas sampled from the powder after the loading experiments [1]. For the nanoPd/ZrO2 system, a high value of hydrogen absorption capacity has been reported [2]. Kitamura et al. have constructed a twin type flow calorimeter to evaluate qualitatively the heat generated by loading of Pd/ZrO2 nanocomposite with hydrogen isotope gases, and have observed anomalously large energies of hydrogen isotope gas adsorption as well as large D/Pd and H/Pd ratio of about 1.1 [3].

In this study, hydrogen or deuterium absorption capacity was measured by using the Sievert's method for Pd nanomaterials; Pd nanopowder, Pd/Al2O3, and Pd/ZrO2. The heat power generated upon pressurizing the materials with hydrogen isotope gases was measured with a flow calorimeter. In order to examine the influence of oxidized Pd on absorption capacity and heat evolution, both of these measurements were conducted 3 to 4 times repeatedly, without exposing the samples to air. Prior to each measurement, the samples were heat treated in vacuum at 523K for 2h, in order to remove the absorbed molecules or to eliminate completely the hydrogen or deuterium absorbed in the preceding measurement. It was found that both absorption capacity and heat evolution depended strongly on the degree of oxidation of Pd. The amount of the oxidized Pd in each sample was estimated from the difference in apparent absorption capacity between the cycles of measurement, and used to estimate the heat generated from chemical reactions.

References

1. Y. Arata and Y. Zhang, *Journal of High Temperature Society* **34**, 85-93 (2008).
2. S. Yamaura, K. Sasamori, H. Kimura, A. Inoue, *J. Mater. Res.***17**, 1329-1334 (2002).
3. A. Kitamura, T. Nohmi, Y. Sasaki, A. Taniike, A. Takahashi, R. Seto, and Y. Fujita, *Physics Letters A* **373**, 3109-3112 (2009).

D + D Fusion Acceleration in High Temperature Acoustic Cavitations

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In 2002, Taleyarkhan et al. reported D + D fusion reaction induced in the acoustic cavitations of deutrated aceton, so-called bubble fusion [1]. It is widely accepted that the temperature in the cavity is, at least, higher than 10^4 K. Furthermore, some hydrodynamic calculations predict 10^{6-7} K [2]. Such a high temperature (keV range) deuterium could induce nuclear fusion. However, the bubble fusion is still in dispute [3].

In this study, we have developed a new ultra sonic system to achieve the acoustic cavitaion in metal liquid Li target. The bolt clamped Langevin type transducer (BLT) is driven under the resonance frequency of 18.85 kHz in the air. The longitudinal wave pass through an Al made horn and is applied to the liquid Li target in a vacuum chamber. Then countless μm order bubbles are generated at the surface of the liquid Li. We bombarded the liquid/cavitation Li target by the low energy (30 – 70 keV) deuteron beam and measured ^{6}Li(d, α)^{4}He and D(d, p)T fusion reaction to investigate the Li + D and D + D bubble fusion.

For all experimental conditions, ^{6}Li(d, α)^{4}He reaction has not been enhanced by the U.S. effect. We found the screening potential of the ^{6}Li(d, α)^{4}He reaction in the liquid/cavitation Li to be 543 eV. The additional electron screening could not be generated by the liquid/gas phase transition. Although the screening potential is higher than the value in the LiF insulator target, it is reasonable because the liquid Li is ionized as Li^+ and e^- and therefore ionic debye screening could be effective.

On the other hand, several times enhancement of the D(d, p)T reaction yield has observed by the U.S. effect. However, the effect is strongly depended on the Li surface condition and unstable. Although the time/depth profile of the deuterium is uncertain, we conjecture that the enhancement is caused by not the screening but high temperature deuterium mobility in the cavity. We fitted the energy dependence of the U.S. ON/OFF yield ratio and obtained the temperature in the cavity as kT_D = 590 eV (6.8 x 10^6 K). Here, we note that no enhancement for ^{6}Li(d, α)^{4}He reaction means the temperature of Li in the cavity is much lower than that of deuterium. This phenomenon has been already theoretically predicted by the MD simulation [2]. The lighter gas is segregated from the heavier gas and selectively compressed in the cavity and then the temperature reach to 10^{6-7} K.

No meaningful bubble fusion event has been observed in this study. However, the experimental results are all consistent with the original reports and numerical simulations. Hence, we can expect the bubble fusion if we can specify the best experimental conditions.

References

[1] R. P. Taleyarkhan *et al.*, *Science*, **295**, 1868 (2002).
[2] A. Bass *et al.*, *Phys. Rev. Lett.*, **101**, 234301 (2008)
[3] New Energy Times (http://www.newenergytimes.com/) and scientific references therein.

Measurements of heat and radiation from Pd nano-powders during absorption of hydrogen isotopes

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In order to confirm heat and ^{4}He generation by deuterium (D) absorption in nano-sized Pd powders reported by Arata and Zhang [1], we installed a twin system of double structured vessels to perform flow calorimetry during D_2 or H_2 absorption by some micronized Pd samples [2]. Then we compared performance of several kinds of Pd powders; 0.1-μm-diam. Pd powder, 300-mash powder of Pd-black and 10-nm-diam. Pd·Zr oxide compounds [3]. In a framework of the assumption that the D_2 (H_2) gas flow rate is determined from the rate of increase of the D_2 (H_2) pressure in the reaction chamber, we conclude that the hydrogen absorption energy is an increasing function of fineness of the Pd powder, and a very large energy of hydrogen absorption by Pd·Zr oxide compounds reaching about 2 eV/D(H) together with a very large D(H)/Pd loading ratio exceeding 1.0.

In the present work, we examine the effect of oxidation of Pd on the observed heat output and D(H)/Pd loading ratio. The large value of the absorption energy and the D(H)/Pd ratio implies that nano-spherical feature of the Pd grains results in an increase in the number of hydrogen adsorption cites as well as a trapping-potential deepening of the cites.

Next, we describe radiation measurements, which include measurements of neutrons with a neutron dose rate meter, γ rays with a scintillation probe, residual radioactivity with an imaging plate, and charged particles with a Si surface barrier detector (SSBD) and an ion-implanted Si detector (IISD). We have observed a tendency that the charged particle counting increases when the D_2 pressure changes, although it is not well confirmed that these signals originate in nuclear events, and the counting rate is far lower than that expected from an assumed nuclear reaction producing α particles.

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[2] T. Nohmi, Y. Sasaki, T. Yamaguchi, A. Taniike, A. Kitamura, A. Takahashi, R. Seto and Y. Fujita; Proc. ICCF14, Washington DC, 2008, paper 15.
[3] A. Kitamura, T. Nohmi, Y. Sasaki, A. Taniike, A. Takahashi, R. Seto and Y. Fujita; Physics Letters A, **373** (2009) pp.3109-3112.

Two absorption/adsorption processes of hydrogen isotopes observed for Pd nano-powders

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In order to confirm heat and ^{4}He generation by deuterium (D) absorption in nano-sized Pd powders reported by Arata and Zhang [1], we installed a twin system of double structured vessels to perform flow calorimetry during D_2 or H_2 absorption by a variety of micronized Pd samples, and observed interesting phenomena [2, 3]. There remained, however, ambiguities on the flow rate of hydrogen isotope gases and the extent of sample oxidation. In the present work, we have made an improvement to equip sub-tanks with pressure gauges to measure time-dependently the flow rate and the amount of hydrogen isotopes absorbed, separately in the first phase and the second phase, by the samples of Pd·Ni·Zr oxide composites in the A_1·A_2 twin system, and performed experiments using samples with two kinds of processing; a forced oxidation of Pd in atmospheric oxygen gas at a temperature of 473 K, and a forced reduction of PdO in atmospheric hydrogen/deuterium gas at a temperature of 673 K.

The evolution of pressure and temperature after introduction of D_2/H_2 gas is divided into two phases (the 1st phase and the 2nd phase). For the oxidized samples, possible de-oxidation reactions, $PdO_x + xD_2\ (H_2) \rightarrow Pd + xD_2O\ (H_2O) + Q_r$, accompanied by deuterium (protium) adsorption and the chemical reaction to form deutrides (hydrides) are regarded in analysis to terminate in the first phase. The D_2 (H_2) absorption runs with oxidized samples have revealed the following facts;

(1) The extent of oxidation of Pd by the above-mentioned processing remains below 10 %.
(2) The D (H) absorption energy in the first phase exceeds 1.5 eV, as has been expected from the results of the earlier experiments [2, 3].
(3) The forced oxidation of used Pd nano-particle samples gave a significant recovering effect on D(H) absorption rate and released amount of heat.
(4) A phase-transition of absorption and adsorption exists between the first phase and the second phase. In the second phase, considerable amount of D (H) gases are observed as “absorbed” probably by a physical adsorption with the output energy less than 10% of that for the first phase. Total D(H)/Pd ratios over the two phases exceeded 2.0, while net D(H)/Pd ratios by absorption in the 1st phase are about 1.0.

[1] Y. Arata and Y. Zhang: The special report on research project for creation of new energy, J. High Temperature Society, 2008, No. 1.
[2] A. Kitamura, T. Nohmi, Y. Sasaki, A. Taniike, A. Takahashi, R. Seto and Y. Fujita; Physics Letters A, **373**, pp.3109-3112.
[3] Y. Sasaki, Y. Miyoshi, A. Taniike, A. Kitamura, A.Takahashi, R. Seto and Y. Fujita; this meeting.

Role of PdO Surface-Coating of Pd Nano-Particle for D(H) Charging and Cluster Fusion

A.Takahashi[2], A. Kitamura[1], Y. Sasaki[1], Y. Miyoshi[1], A. Taniike[1], R. Seto[2] and Y. Fujita[2]
[1] Kobe University, [2] Technova Inc.

We of the Kobe Group will report newer results on anomalous D(H) absorption and excess heat by nano-Pd/Metal-Oxide dispersed samples by separate reports in this JCF10 meeting. Reduction process of PdO in samples under D(H) charging is first discussed in this paper. Secondly, the role of PdO surface coating of Pd nano-particle is discussed using a speculative model on what happens under D(H) charging to induce the D-cluster formation and 4D/TSC fusion.

We summarize discussions as;

1) The de-oxidation of PdO may be made mostly during the baking processes between D(H)-loading runs.
2) The PdO-coated layer of Pd-nano-particle may arrange fractal nano-dips on its surface when D(H)-gas is charged and de-oxidation molecules (D_2O or H_2O) are released.
3) Fractal nano-dips may make local deep adsorption potentials, through which rapid penetration of D-atoms (ions) into deeper Pd-local lattice (Bloch potential) O-sites of nano-particle may be induced, to realize full or over-full D(H) loaded state ($x>1.0$) of PdD_x in a short time of the Phase-I process.
4) Formation of D-clusters, such as 4D/TSC on surface may be enhanced at nano-dips.
5) D-motion in a “mesoscopic deep collective potential” of the nano-PdD_x system may be quasi-free to enhance transient D-cluster (4D/TSC) formation probability around tetrahedral sites of local Bloch (periodical-lattice) potential inside a PdD nano-particle. This state can be modeled by the non-linear combination of two oscillations, i.e., one by the deep (about 1.5eV deep) well-type collective potential and the other by the lattice-type periodical three dimensional Bloch potential (about 0.22eV deep).

A power spectrum change by irregular periodicity of superlattice at tunnel resonance of CF

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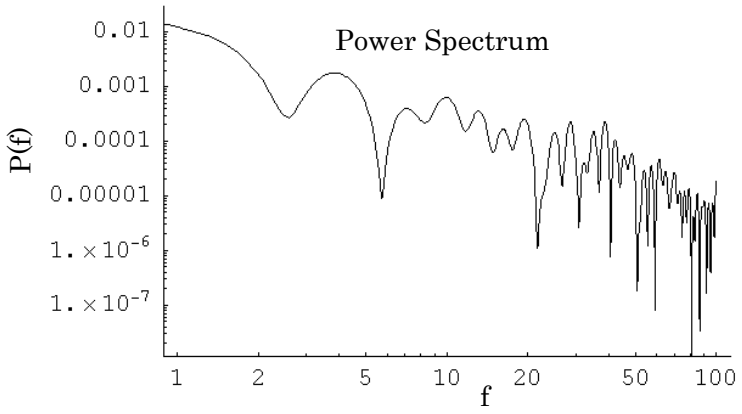
The generation of heat and emissions of neutron or charged particles by CF are occurred with an electric direct current flowing. Nuclear transmutations are also observed by forced gas permeation experiment. Those phenomena of CF have been commonly caused by a flow of quanta. We can postulate charged particles, e.g. electron and deuteron as a quanta which transmission is governed by tunnel resonance of supperlattices. The hypothesis realizes such anomaly of the CF phenomena related with quantum transport of charged particles under alternating sequence of potential barriers and wells in the constant electric field. (the Kronig-Penny model). Ban already proposed that matter wave propagates within the lattices in a tunnel resonant state[1, 2, 3].

On the other hand, Nakamura et al. [4] reported that quantum transport behavior exhibits a global chaos and 1/f low with the power spectra of the transmission coefficients. In this study, the deviation of the periodicity of the potential barriers and wells is introduced to study the nonstationary quantum transport of a little disturbed superlattices. Numerical simulation of quantum transport has been performed using T matrices of the 1D structures.



Transport properties of delta-function model for m_e=0.067, d=0.1, $V_0 d$ =1, F=0.001, k_0 =10 with 0<randomized a<2nm power spectrum P(f) in logarithmic scales. $P \propto f^{-2}$

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2)M.Ban, Cold fusion associated with three kinds of matter wave resonance, Proc.6th Meet.Japan CF Research Soc.,p.86-89, 2005

3)M. Ban, Proc. Tunnel Resonance of Electron Wave and Force of Fluctuation, ICCF12, pp.451-455, Yokohama, 2005

4) T. Haga, Y. Takane and K. Nakamura: $1/f^2$ Law in One-dimensional Quantum Transport: an Example of Weak Chaos in Quantum Systems, Chaos Solutions & Fractals, Vol. 5, No. 7, pp. 1077-1083, 1995.

A theoretical study on the possible change of the phonon dispersion relation due to the nuclear reaction in solid Ⅱ

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Abstract

We have studied relations between nuclear reactions in solids and the change of phonon dispersion relations, experimentally [1,2] and theoretically [3,4]. In these studies, we have pointed out that we can detect the changes of phonon dispersion relations induced by nuclear reactions in solids because phonon dispersions are strongly affected by the geometric and electronic structure of the crystals.

In this study, we have summarized them and shown the method to do the predictions of the possible changes in the one-dimensional phonon dispersion relations. They are very simple models but they can give useful predictions to know the changes in the atomic compositions of the one-dimensional crystals induced by the nuclear reactions in solids. We can also expand them to the real case in three-dimensional space.

References

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2. K.Tsuchiya, A.Watanabe, M.Ozaki and S.Sasabe, "Observation of optical phonon in palladium hydrides using Raman spectroscopy", proceedings of ICCF14 (to be published)
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4. K.Tsuchiya, S.Sasabe, M.Ozaki, "The effects of nuclear reactions in solids on the phonon dispersion relation", proceedings of ICCF15 (to be published)

Simulation of Uranium and Palladium Fission Products Using a Lattice Model

N. D. Cook *(Kansai University),* **V. Dallacasa** *(Verona University)*

The nucleon build-up procedure for the Palladium and Uranium isotopes is known from the independent-particle model and implies specific 3D structures for these isotopes in the nuclear lattice model [1, 2]. Using those lattice structures, the favorable modes of fission have been simulated and the fission fragments compared with (i) the known fission fragments from Uranium, and (ii) the transmutation products from Palladium, as reported by Mizuno [3]. It is shown that (i) the changes in relative abundance of the Pd isotopes, and (ii) the main transmutation products in Mizuno-style LENR studies are consistent with the idea that the bulk of the energy released in such experiments is due to the fission of Pd isotopes.

We have previously reported that a lattice model of nuclear structure [1, 2] – essentially identical to the "independent-particle model" (IPM) – predicts the asymmetrical fission fragments produced by the thermal fission of the actinides ***without*** using any "adjustable parameters" to produce the asymmetry. The basic effect is a consequence of the fact that scission along oblique lattice planes of the somewhat oblate lattice structures for the actinide nuclei requires breaking fewer nearest-neighbor nucleon-nucleon "bonds" than symmetrical slices through the same structures. Because of the large excess of neutrons that give the actinides an oblate shape, the oblique slices through the lattice structures show a 3:2 mass ratio (Figure 1). That result can be verified using the *Nuclear Visualization Software*, available at: http://www.res.kutc.kansai-u.ac.jp/~cook. Similarly, the fission of Palladium can be simulated using the same software, and shows that the symmetrical fission of the approximately spherical Palladium structures is energetically favored.

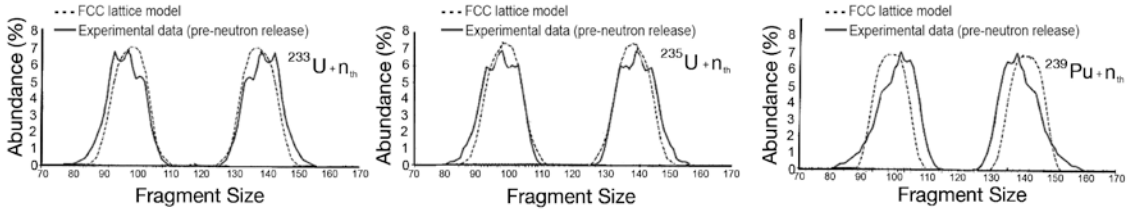
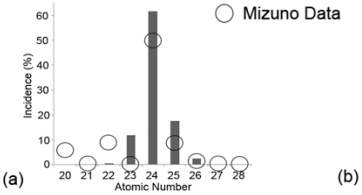


Figure 1: The prediction of asymmetrical fragments in the thermal fission of the actinides [2] using a lattice model that employs no parameters to produce the fission phenomena.

Here, we apply the ***same*** lattice technique to the fission of the six stable Palladium isotopes. The results of the simulation in comparison with the Mizuno data [3] are shown in Figure 2. By restricting the simulation to the nine most stable lattice structures, the primary fission fragments from each of the Palladium isotopes was Chromium. The large excess of Chromium isotopes found experimentally was well-reproduced, although fragments with relatively large and small atomic numbers (12, 14, 16, 20, 29 and 30) were not found in the simulation. Large increases in Cr^{53} and Cr^{54} and a large decrease in Cr^{52} were also predicted, as found in the Mizuno data, but not the decrease in Cr^{50}.



	Cr^{50}	Cr^{52}	Cr^{53}	Cr^{54}
Natural abundance	4.3%	83.8%	9.5%	2.4%
After electrolysis (expt)	14.3%	50.9%	23.8%	10.9%
Simulation	0.0%	7.9%	76.8%	15.3%

Figure 2: (a) A comparison of simulation results (bar graph) and the data from Mizuno [3], indicated by the open circles. (b) A comparison of the changes in the natural abundances of the four main Chromium isotopes following electrolysis.

The nuclear lattice model does not require any additional parameters to explain the asymmetry of Uranium fission fragments. Similarly, we find that the symmetrical pattern of experimentally-known nuclear "ash" in Mizuno-style cold fusion experiments is obtained from the same lattice-scission technique. We therefore conclude that the substructure provided by the nucleon lattice is a necessary addition to conventional nuclear structure theory and allows for an explanation of the masses of the fragments produced by both the thermal fission of Uranium and the nuclear transmutations detected in "cold fusion" experiments.

[1] N.D. Cook & V. Dallacasa, *Phys. Rev.* C36, 1883 (1987), *J. Physics* G20, 1907 (1994); G25, 1213 (1999); etc.
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Cellular automata numerical simulation of cascade vortices

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During a long-term electrolysis for well annealed thick Pd rod (9.0 mm ϕ) in 0.1M LiOD vortex patterns were observed. [1-2] So far, Numata et al. performed numerical simulation: the modified cellular automata to study the cold fusion and related phenomena. We have obtained the vortex pattern past a plate in the downward stream where the time evolution of an incompressive fluid flow was calculated under the low of hydrodynamics. [3-4] Although the numerical simulation result for the prototype vessel containing a vortex was obtained, there will be remained problems for more advanced simulation model. One step to gain an acceptable simulation result was realization of a robust boundary condition. [5] Next the cascade of many vortices in the trained vessels will be simulated where the fluid moves from a vessel to a neighboring one. [6] Finally the dynamics of the cascade: i.e. vortex threads in 3D space will be analyzed to simulate the vortices appeared on the electrode surface during electrolysis. In the numerical simulation studies the nature of the hypothetical particles mass will be elucidated in the relation with the CF anomaly, e.g. high /low energy process, traces of local energy deposition and so on.

In this study, the computational power is evaluated during parallelization in terms of PC core number. The preliminary cascade model will be presented by introducing the former analyzed boundary condition. [5]

References

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4) H. Numata and M. Ban: Proc. JCF6, pp.32 (2005)

5) H. Numata and M. Ban: Proc. JCF9, pp.74 (2009)

6) H. Numata and M. Ban: Proc. JCF8, pp.67 (2008)

Abraham-Lorentz-Dirac Equation in Quantum Mechanics: The Beginning of Weakened Coulomb Potential

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A weakened Coulomb potential was suggested(1) to overcome the Coulomb barrier between deuterons in palladium. The derivation of weakened Coulomb potential(2) is based on the nonrelativistic limit of the Lorentz-Dirac equation, which is called the Abraham-Lorentz (AL) equation. Although the validity of the AL equation was proved by Italian researchers about half a century ago, it is not so familiar to most of physicists and their scheme was fairly complicated. Using Crisp's method(3), we have derived the AL equation from quantum mechanics by means of Ehrenfest's theorem(4) in relatively simple way. It is found that the dipole approximation is essential to obtain the AL equation.

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Computer Simulation of States of Hydrogen in Metals of Face Centered Cubic Lattice

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Nuclear reactions such as nuclear fusion and nuclear transmutation in condensed matter have been reported. Since nuclear reactions occur within condensed matter such as metals, it is required for more than one hydrogen or deuterium to gather and condense in the narrow domain of the host metal.

Then, in order to examine which kind of conditions cause two or more hydrogen in metals to gather, we simulated the motion of hydrogen by using a classical molecular dynamics on a personal computer, and furthermore we calculated the corresponding total energy, charge density and electronic structure by using a quantum molecular dynamics on the another one.

By the classical molecular dynamics, we simulated the motion of hydrogen in the bulk of nickel which atomic potential was well known comparatively, imposing the periodic boundary conditions on the calculation supercell of 3x3x3 unit cells, changing temperature and the content of hydrogen located on O sites, and we compared it with the case where a vacancy is included and/or an impurity atom is included. In the metal of face centered cubic lattice, we observed the tendency for movement of hydrogen to be increased when temperature rose, but the tendency for movement to be suppressed when the content of hydrogen increased. Moreover, when hydrogen moved from O site to another one, we observed it moved through T sites, and sometimes it stayed at T site for a short time.

By the quantum molecular dynamics within Density Functional Theory based on the local density approximation using pseudo-potentials and a plane-wave basis, we calculated the total energy, charge density and electronic structure of the host metal lattice such as the bulk of nickel and palladium etc. of the metals of face centered cubic lattice, when hydrogen was located on an O site and a T site of it, imposing the periodic boundary conditions on the calculation cell of 1x1x1 unit cell of the most minimum. We observed the energy of state where hydrogen located on the O site was lower than that on the T site, and then we simulated the state when those energies are reversed by deforming the lattice structure. And moreover, we are carrying out the simulation of the case where a vacancy is included and/or an impurity atom is included, expanding the calculation supercell.

Charged Particle Detection during Gas Loading/Permeation Experiment with ΔE – E Si Counter Telescope

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As we have reported at recent ICCF and JCF series, a few counts but high energy charged particle signals had been observed when D_2 gas permeate through Pd samples [1,2]. Toward high reliability, we have developed the extremely low background detection system to identify such a rare event. YAP(Ce)/BC444 phoswich detector system showed the possibility of 30 MeV over charged particle emissions. However, the energy resolution of that system is so worse (over 20% for 5.5 MeV α) that the identification of the particle energy is difficult due to the lack of statistics. 23.8 MeV monoenergetic alpha particle emission cannot be concluded.

We therefore changed the main detector to a Si semiconductor detector (SSD) in order to identify the particle energy with high energy resolution. Since the SSD is placed in the reducible D_2 atmosphere, a surface barrier type SSD cannot be used because of the deterioration of the surface SiO_2 layer. Two ion implanted type SSDs (ΔE: Canberra PIPS 300 mm^2, 150 μm, & E: ORTEC Ultra 450 mm^2, 300 μm) consist of a ΔE – E counter telescope. The other detection apparatuses are same as the previous reports [1,2].

In this study, not only the conventional MHI-type Pd/CaO complexes [3] but also Arata-type Pd/ZrO_2 nano particles [4] were tested. The particles were supplied from IMR Tohoku Univ., and thin deposited on the Cu foil at KEK [5].

We tested some samples and detected high energy charged particles from some of them at the first phase of D_2 absorption. The energy is over 30 MeV that is consistent with the results obtained from the YAP(Ce)/BC444 phoswich system. The maximum energy observed is about 40 MeV. It is quite curious that observed energy is clearly higher than 23.8 MeV. Furthermore, the energy was all deposited to the ΔE detector and no meaningful signal was observed from the E detector at that time. This means two possible explanations: (1) the detected particle is heavier than the alpha particle and stopped within the ΔE detector, (2) many (4 or more than) alpha particles were emitted simultaneously. In this case, each alpha energy should be less than 15 MeV.

The reproducibility of high energy charged particle emission is 1/3 for Pd/ZrO_2 nano particle, 2/5 for Pd/CaO complexes. At present, the number of counts is so small that it is hard to conclude the phenomenon. Such high energy particles, however, have not been observed in background measurement, but observed only in the first phase of D_2 gas absorption.

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Search for Nuclear Events in Deuterium Discharge Experiment Using Multi-layered Metal Cathode

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We have performed discharge experiment using Pd cathode in deuterium atmosphere, and observed possible nuclear products and radiations, which were considered as the evidence of low energy nuclear reaction (LENR) in condensed matter. Those results demonstrate that the discharge method is valid for inducing LENR.

It has been shown by several researchers that loading nano-structured sample, such as Pd powder or thin Pd film, with deuterium results in inducing LENR with high reproducibility. Considering these results, we have tested multi-layered Pd cathode in deuterium discharge, and searched for the nuclear events induced.

In this experiment, we prepared multi-layered Pd/Pd and Pd/Pd/Au samples in the following procedure. On the Pd substrate (10 mm x 10 mm x 0.1 mm in size, and >99.95% in purity), 400 nm Pd layer and/or 1200 nm Au layer were formed by Ar^+ sputtering. The multi-layered sample was put as the cathode into the discharge cell made of stainless steel. The stainless anode was used and the gap distance between the electrodes was set to be ~10 mm. After evacuating the cell to 10^{-2}-10^{-3} Torr, deuterium gas is supplied until inside pressure became 1 Torr, followed by applying DC voltage to expose the multi-layered sample to discharge with currents of ~1mA and voltage of ~500 V. It was so-called glow discharge condition. The set of CR39 detectors was placed surrounding cathode to detect charged particles emitted during the discharge. The element composition of the cathode was analyzed by TOF-SIMS and ICP-MS and searched for newly produced elements as well as anomaly in isotopic abundance for the elements detected. In this paper, we report the results in particle detection and elemental analysis and discuss the characteristics of nano-structured metal sample in the discharge experiment.

Anomalous tracks recorded on CR39 in deuterium desorption experiment

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It has been considered that unique properties of multi-layered sample in deuterium diffusion process are concerned with trigger condition for low energy nuclear reaction (LENR) in condensed matter [1,2], and understanding the deuterium dynamics in such sample may lead us to clarify the mechanism of the reaction. We have examined various types of multi-layered sample and the behavior in deuterium desorption process followed by nuclear phenomena. For some types of the sample, we observed explosive deuterium desorption simultaneously with anomalous heat evolution which was hardly explained by a chemical reaction [3]. We have supposed that the instantaneous deuterium diffusion is related to the nuclear effect. Among the various multi-layered samples we tested, the Pd membrane coated onto Pd foil promotes the deuterium desorption [4]. Now it is expected to induce LENR in condensed matter effectively with such sample.

We have investigated multi-layered samples which contain Pd membrane such as *Pd*/Pd, *Pd*/Pd/Au, and *Pd*/*CaO*/Pd/*Au*. These samples were fabricated by depositing Au, CaO, and Pd layers by Ar ion beam sputtering onto the surface of Pd substrate, respectively. The sample was loaded with deuterium by pressurized method. We found that the loading ratio has a dependence on the type of coating material as well as its thickness. After loading with deuterium, the sample was put into the evacuated chamber and investigated time-resolved gas desorption behavior. The CR39 detector was utilized to search for charged particle emission during the experiment. In the several experiments, numerous tracks were recorded on CR39 detector. In some cases, the profile of tracks on CR39 was apparently different from the background ones.

In this paper, we report deuterium absorption/desorption behavior for Pd multi-layered sample, and anomalous tracks on CR39 recorded during the desorption process. Then, the origin of the tracks will be discussed.

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Detection of Energetic Charged Particle from Thin Ni Cathode in Shortened Li_2SO_4/ H_2O Electrolysis Using Track Detector CR-39

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We have been studied low energy nuclear reaction (LENR) for hydrogen system using TOF-SIMS [1-3]. These results suggested newly producing elements as well as the case for deuterium system. On the other side, the experimental studies using Li_2SO_4/H_2O electrolysis and Ni cathode have yielded positive results for LENR with higher reproducibility. Record on plastic track detector such as CR-39 has been also preferably used in investigating the LENR for light water electrolysis, because of giving direct evidence of the phenomena. However, the high density of solution surrounding the electrode will considerably decrease the detecting efficiency of the particles.

In the present investigation, the CR-39 was set as being closely contacted with the 5 μm thickness Ni Cathode. This thin Ni film formed the bottom of the test cell in 0.1 M Li_2SO_4 light water solution. This construction can minimize the energy loss of charged particle through the thin Ni cathode and maximize the detecting efficiency of emitting particle. The volume of solution was 8.5 cc. The anode was 155mm length and ϕ 0.5 mm Pt wire, which formed a spiral of ϕ ~5 mm. The distance between the tip of anode and the Ni cathode was ~10 mm. The electrolysis time was only ~20 min by constant DC ~20 mA and ~6 V application. The short detecting time of 20 min have an advantage of minimizing the noise from the environment. The CR-39 used was cut into 30×30 mm in size just before the electrolysis. Several reference tests using CR-39 were performed just after electrolysis tests. The reference tests have also performed simultaneously with the electrolysis tests. The etching time of CR-39 surface by 5 M NaOH was 7h.

Ten series of electrolysis experiments and more than ten series of reference tests were carried out successfully. Comparing with the case for reference tests, we have observed a marked increasing number of etch pit on CR-39 only after the electrolysis. The emitting particle seems to have wide energy range of the order of MeV. The result strongly indicates the LENR for this hydrogen system.

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