The 12th Meeting of Japan CF-Research Society

JCF12 ABSTRACTS

December 17-18, 2011

Kobe University

Japan CF-Research Society

Program of JCF12 Meeting

Japan CF-Research Society

Date: December 17-18, 2011
Place: Umeki Y Hall, Fukae Campus, Kobe University, Kobe, Japan
Paper presentation: Oral presentation 20 min. (Review: 25min) + Discussion 5 min.
Language= English or Japanese
Book of Abstract: Only available at JCF home page;
http://jcfrs.org/

December 17 (Sat.), 2011

12:00-13:00 **Registration**
13:00-13:10 **Opening Address** (A. Kitamura, Kobe U.)

Experiment-1 (Chairman: Y. Iwamura, Advanced Tech. Research Center, M. H. I. H.)

13:10-13:35 **JCF12-1** Y. Miyoshi (Kobe U.) et al.: Gas-phase hydrogen isotope absorption/adsorption characteristics of a Ni-based sample
13:35-14:00 **JCF12-2** H. Sakoh (Kobe U.) et al.: Silica-included Pd nano-powders repeatedly available for heat production by hydrogen isotope absorption
14:00-14:25 **JCF12-3** T. Kamihira et al. (Iwate U.): Investigation of nuclear phenomena in deuterium adsorption to Pd film
14:25-14:50 **JCF12-4** S. Kosaka et al. (Toyota Central R&D Labs.): Detecting Pr in Cs ion-implanted Pd/CaO multilayer system before and after D_2 gas permeation

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

Review (Chairman: S. Narita, Iwate U.)

15:05-15:35 **JCF12-R1** Y. Iwamura (Advanced Tech. Research Center, M. H. I.) et al.: Status of Transmutation Experiments induced by Deuterium Permeation though Nano-structured Pd Multilayer Thin Film
15:35-16:05 **JCF12-R2** A. Kitamura (Kobe U.): Review of gas-phase hydrogen isotope absorption/adsorption experiments
16:05-16:35 **JCF12-R3** A. Takahashi (Osaka U. and Technova Inc.): Review of TSC Model on CMNS/CF Phenomena

16:35-18:00 **JCF Annual Meeting**

18:00-20:00 **Reception**

December 18 (Sun.), 2011

Theory -1 (Chairman: M. Ozaki, Tokyo U. of Agriculture)

10:00-10:25 **JCF12-5** H. Numata (Tokyo Institute of Tech.): Search for advanced simulation model of cascade vortices underbeneath of the electrode surface

10:25-10:50 **JCF12-6** K. Tsuchiya (Tokyo T. N. C. T.): Theoretical study of nuclear reactions in solids using Bose-Einstein condensation model

10:50-11:15 **JCF12-7** A. Takahashi (Osaka U. and Technova Inc.): Kinetic Reaction Energy of Cold Fusion

11:15-11:40 **JCF12-8** H. Kozima (CF Res. Lab.) et al.: The Cold Fusion Phenomenon in Hydrogen Graphites

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

Experiment-2 (Chairman: Y. Toriyabe, Hitachi-GE Nuclear Energy, Ltd.)

13:00-13:25 **JCF12-9** S. Narita et al. (Iwate U.): Deuterium desorption test using Ni/Pd multi-layered sample

13:25-13:50 **JCF12-10** Y. Abe et al. (Iwate U.): Change in Isotopic Ratio of Li by Light Water Electrolysis

13:50-14:15 **JCF12-11** K. Mita et al. (Iwate U.): Numerous etch pits on CR-39 produced by light and heavy water electrolysis

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

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

14:30-14:55 **JCF12-12** H. Miura: Computer Simulation of Hydrogen States in Pd Metal of Face Centered Cubic Lattice

14:55-15:20 **JCF12-13** H. Kozima (CF Res. Lab.): Three Laws in the Cold Fusion Phenomenon in Open, Nonequilibrium, Multi-Component Systems

15:20-15:45 **JCF12-14** A. Takahashi (Osaka U. and Technova Inc.): 4H/TSC Fusion by Simultaneous Weak and Strong Interactions

Adjourn

Gas-phase hydrogen isotope absorption/adsorption characteristics of a Ni-based sample

Y. Miyoshi[1], H. Sakoh[1], A. Taniike[1], A. Kitamura[1],
A. Takahashi[2], T. Murota[3] and T. Tahara[3]
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Gas-phase hydrogen isotope absorption/adsorption characteristics of ternary compound of Cu-Ni-ZrO_2 (CNZ, Santoku Corp.) have been examined. The twin absorption system consisting of two equivalent sets of reaction chambers and the reservoir tank filled with D_2 and H_2 gas, respectively, has been employed. The flow rates of D_2 and H_2 gas into the reaction chambers after an absorption run starts are regulated with "Super Needle" valves.

Since the sample absorbed negligible amount of hydrogen isotopes at room temperature, the absorption runs were done at elevated temperature without accurately time-resoloved calorimimetry (namely mass flow calorimetry). The sensitivity, increase in temperature per input power, was determined to be about 0.3 K/W system, and the time constant to be 16 min due to thermal radiation and 46 min due to conduction, from runs introducing He gas instead of hydrogen isotopes at temperatures up to 523 K under 70 W input power.

From time-dependent measurements of the pressure and the sample temperature in comparison with the He-gas-flow blank runs, time-integrated specific heat release and hydrogen isotope loading ratio D/Ni (H/Ni) were deduced. The preliminary results infer that the sample showed exothermic property at temperatures above about 470 K, while endothermic data were observed at temperatures lower than 370 K.

Silica-included Pd nano-powders repeatedly available for heat production by hydrogen isotope absorption.

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It has been reported that large heat release was observed by absorption of hydrogen isotopes by Pd nanopowders included in the basket structure of zeolite [1]. Purpose of inclusion in the basket structure is to prevent agglomeration of nano-particles of Pd under repeated use.In the present study we have used silica-included Pd nanoparticles manufactured by Admatechs Co., Ltd. instead of zeolite-included one. The twin absorption system, which we have been using for experiments on hydrogen isotope gas absorption of various types of oxide nano-composites of Pd [2], consists of two equivalent sets of reaction chambers and the reservoir tank filled with D_2 (or H_2) gas before an absorption run starts. The flow rate of D_2 (or H_2) gas is regulated with a "Super Needle" valve. For calorimetry, the coolant water is kept constant (±0.1 °C) at room temperature with a chiller.

Both the observed loading ratio and the specific heat release in the first phase of the as-received samples were very large: D/Pd and H/Pd exceeded 3.0, and $E_{1D(H)}$ = 2.6 (2.5) ± 0.05 (0.05) eV/atom-Pd. The latter is converted to hydridation energy, $Q_{D(H)}$ = 0.76 (0.71) ± 0.02 (0.02) eV/atom-D(H) neglecting the energy of hydrogen pick-up. Dynamic sorption energy data (η-values) showed the existence of two sub-phases (phase-Ia and phase-Ib) in the phase-I loading. The averaged η-values are around 1.0 eV and 0.2 eV, respectively for phase-Ia and phase-Ib, with considerable isotopic difference.

In the case of forcibly de-oxidized samples, the parameter values D(H)/Pd ≈ 1.0, $E_{1D(H)}$ = 0.21 (0.21) [eV/atom-Pd], and $Q_{D(H)}$ = 0.22 (0.21) [eV/atom-D(H)], were similar to those of bulk Pd samples. Time-dependent η-values are almost constant (near 0.2 eV) in the phase-I loading.

In the case of forcibly oxidized samples, the loading ratio and the amount of released heat were both proportional to the fraction of oxidization. If we assume that the released heat includes the energy of formation of D_2O (H_2O) via the oxygen pick-up reaction, PdO +D_2 (H_2) →Pd +D_2O (H_2O) +Q_{red}, with the published formation enthalpies, we have negative energies for hydrogen isotope absorption; Pd + (x/2)D_2 (H_2) → PdD_x (PdH_x) +Q_D. We have to assume that the H_2O formation energy Q_{red} is substantially smaller than Q_D due to unidentified effect of the nanoparticle surface, or that oxygen pickup reactions do not significantly take place. Possibility of water formation will be discussed with time-dependent data of cell-chamber pressure vs. D(H)/Pd loading rate. The similar results were obtained in the repeated runs using repeatedly oxidized samples, which means that the sample structure keeps off the clamping together.

[1] D. A. Kidwell, A. E. Rogers, K. Grabowski and D. Knies; *15th International Conference on Condensed Matter Nuclear Science*. 2009. Rome, Italy: ENEA.
[2] A. Kitamura, Y. Miyoshi, H. Sakoh, A. Taniike, A. Takahashi, R. Seto and Y. Fujita; J. Condensed Matter Nuclear Science, 5 (2011) pp.48-57.

Investigation of nuclear phenomena in deuterium adsorption to Pd film

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In the deuterium absorption/desorption process for the thin-layered metal sample, charged particle emission and anomalous exothermic reaction have been observed, and those phenomena have been considered to be the evidences of the low energy nuclear reaction (LENR). In addition, it has been widely recognized that the LENR can be induced effectively in the deuterium absorption/desorption for the nano-particles. These results suggest that the specific properties of fine-structured metal help the trigger efficiency of the LENR enhance and it is important to understand the deuterium behavior in such samples for clarifying the mechanism of LENR. In this study, we conducted absorption/desorption of deuterium by the temperature control with thin Palladium (Pd) film deposited onto the Nickel (Ni) foil. During the experiment, the pressure in the chamber and the sample temperature were measured and searched for the anomalies in the behaviors attributed to the nuclear reaction.

The Pd layer with the thickness of 120 ~ 140 nm was formed on the Ni foil (10 mm x 10 mm x 0.1mm). The fabricated sample was put into the chamber. After evacuating the chamber to $<10^{-1}$ Pa, the deuterium gas is supplied until inside pressure became 500 Pa. Then, the chamber was heated and cooled to give a dynamic motion to the deuterium gas inside. We expected that the deuterium loading and unloading to the sample were induced by the temperature control. The CR-39 track detector was put into the chamber for observe the particle emission. We also characterized the Pd film sample by AFM, SEM, and XRD to clarify the conditions for triggering the LENR.

Detecting Pr in Cs ion-implanted Pd/CaO multilayer system before and after D_2 gas permeation

Satoru Kosaka, Naoko Takahashi, Tatsumi Hioki and Tomoyoshi Motohiro
Toyota Central R&D Labs., Inc.

Iwamura et al. reported that Cs was converted to Pr by deuterium (D_2) gas permeation through the Pd substrate covered with a Pd/CaO multilayer system in 2002 [1]. Few following experiments, however, have successfully reproduced their results, probably because the amount of Pr generated from Cs is too small to detect and distinguish from contamination.

Here we have investigated the performance of trace Pr detection for several kinds of analysis methods, and carried out an experiment to reproduce the Iwamura's result using the selected analysis tools.

We compared the detection sensitivity among GD-MS (Glow Discharge Mass Spectrometry), LA-ICP-MS (Laser Ablation Inductively Coupled Plasma Mass Spectrometry), and ICP-MS (Inductively Coupled Plasma Mass Spectrometry), using reference samples that were doped with given concentrations of Pr. We concluded that ICP-MS was most adequate for replication experiment of Iwamura's research, because it had the highest performance of sensitivity and quantitative determination.

Pd substrates (purity: 99.95%) of 100μm in thickness were obtained from TANAKA KIKINZOKU KOGYO K.K. The as-purchased substrates were heat-treated in vacuum (5×10^{-5}Pa) at 1173K for 15h and subsequently in the air at 873K for 10min to remove impurity atoms. Next, Pd/CaO multi layers were formed on the Pd substrates by PLD (Pulsed Laser Deposition). Then Cs atoms were implanted in the multilayer at 65keV and a dose of 1×10^{14}ions/cm^2. Subsequently, the Pd substrates were heat-treated in the air at 573K for 10min in order to remove carbonaceous materials deposited during the ion implantation. The samples were then subjected to D_2 gas permeation treatments at 423K and 9atm for about 250h. The D_2 permeation system was the same with our previous report [2,3]. The upstream side was filled with D_2 of 900kPa. The purity of the D_2 gas was 99.995%. The downstream side was evacuated with a dry pump and a turbo molecular pump. After the D_2 permeation, we dissolved the Pd substrates by nitric acid or aqua regia and analyzed them by ICP-MS (Agilent: 7700X).

We detected approximately 0.5ng/cm^2 of Pr by ICP-MS from the D_2 permeated Pd/CaO multi layer samples with implanted Cs atoms. This result was reproduced 3 times. Moreover, we investigated the back ground level of Pr in comparison samples. We detected 0.005ng/cm^2 in the Pd substrate only having the Pd/CaO multilayer by PLD, and 0.006ng/cm^2 in the Pd substrate only having Cs atoms by the ion implantation. We concluded that the determined Pr amount of the D_2 permeated samples was larger than those of the comparison samples.

However, we need further verification whether the detected Pr atoms are generated by nuclear reaction or not.

-References-

[1] Y. Iwamura, T. Itoh and M. Sakano, Jpn. J. Appl. Phys. 41, 4642 (2002)

[2] T. Hioki, N. Takahashi and T. Motohiro, Proc. ICCF13, Sochi, Russia, pp.518-528 (2008)

[3] J. S. Gao, T. Hioki, N. Takahashi and T. Motohiro, J. Vac. Sci. Technol. A28 (1) 147 (2010)

Status of Transmutation Experiments induced by Deuterium Permeation though Nano-structured Pd Multilayer Thin Film

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Low energy nuclear transmutations in condensed matter have been observed in the nano-structured Pd multilayer complex, which are composed of Pd and CaO thin film and Pd substrate, induced by D_2 gas permeation through Pd multilayer complexes[1]. 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"* measurements using x-ray fluorescence spectrometry (XRF) at SPring-8 in Japan. Similar experiments have been performed by researchers of Univ. of Osaka, Iwate and Toyota Central R&D lab, etc., and positive results have been obtained in some cases. However, more systematic experiments are required for making clear the nature of this permeation induced transmutation.

A micro-beam NRA system, by means of a resonant nuclear reaction $^{1}H(^{15}N,\alpha\gamma)^{12}C$, has been developed for the purpose of the 3D mapping of the hydrogen distribution in solids under a CREST program of JST(Japan Science Technology Agency)[2]. Using this system, we measured hydrogen density near surface in Pd multilayer thin film during permeation. Obtained results on H/Pd distribution in Pd/CaO thin multilayer film will be reported.

We are trying to make clear what elements can be transmuted by our permeation method. Preliminary experimental results on transmutation of W into Os and Pt will be presented. Also we will discuss how to increase amount of transmutation products and future tasks.

[Reference]

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Review of gas-phase hydrogen isotope absorption/adsorption experiments

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Gas-phase hydrogen isotope absorption/adsorption experiments performed since 2008 at Kobe University are reviewed. The samples include 0.1-μm-diam. Pd particles (PP, Nilaco Corp.), Pd-black (PB, Nilaco Corp.), nano-composites of PdO and ZrO_2 (PZ, Santoku Corp.), porous-silica-included Pd nano-particles (PS, Admatechs Co. Ltd.), ternary oxide compound of PdO·NiO·ZrO_2 (PNZ, Santoku Corp.), and binary oxide compound of NiO·ZrO_2 (NZ, Santoku Corp.), and PdO·NiO nanoparticles dispersed in ZrO_2 powders provided by A. Ahern (PNZ2B).

A twin absorption system consisting of two equivalent sets of reaction chambers and the reservoir tank filled with D_2 and H_2 gas, respectively, has been employed. The flow rates of D_2 and H_2 gas into the reaction chambers after an absorption run starts are regulated with "Super Needle" valves. For calorimetry a chiller is provided to keep the coolant water temperature constant within an error of ±0.1 °C.

Time-dependent measurements of the temperature and the pressure enable measurements of time-dependent specific heat release E, dynamic loading ratio L_D (L_H) of hydrogen isotopes, dynamic sorption energy η_D (η_H), as well as time-integrated parameters such as hydrogen isotope loadidng ratio D/Pd (H/Pd) and hydridation energy Q_D (Q_H). Radiation detectors, such as a neutron doserate meter, an ion-implanted Si detector and a Si-PIN diode are also provided for time-dependent measurements of neutrons, chaged particles and X-rays.

Based on the results of the extended measurements, the effects of the sample structure on the absorption/adsorption characteristics are discussed; particle size, oxide formation on the Pd samples, the silica-inclusion of Pd nanoparticles, and Ni-substitution for Pd. In particular, anomalous results have been repeatedly observed in the heat evolution, the total D/Pd (H/Pd) loading ratios and the η-values, which were significantly enhanced for the nano-particle samples dispersed in ZrO_2 or included in porous-silica.

Most of the experiments have been conducted as a joint research with Technova Inc. in collaboration with A. Takahashi, T. Nohmi, Y. Sasaki, Y. Miyoshi, H. Sakoh, A. Taniike, R. Seto and Y. Fujita.

Review talk at JCF-12 A. Takahashi

Review of TSC Model on CMNS/CF Phenomena

Akito Takahashi (Osaka University and Technova Inc.)

Recent progress in the TSC theory on explaining claims of radiation-less anomalous heat generation in CMNS/CF research is briefly reviewed.

Physical principle of cold fusion is summarized by the results of the TSC theory on 4D/TSC (4D simultaneous multibody fusion) and 4H/TSC (4H weak-strong simultaneous interaction) reactions. (Detail will be shown in contributed papers in JCF12.)

Latest experimental results (Kobe-Group, NRL, Colorado) by the D(H)-gas loading with nano-metal-particle/ceramics-supporter powders are explained with the aspect of anomalously large “chemical” heat, to be modeled as the mesoscopic catalyst effect of sample-powders, which may however induce microscopic sites for cluster D(H)-nuclear-fusions. Phenomenological modeling is shown.

(Extended review paper, “Cold Fusion Frontiers 2011” -in Japanese- on the TSC theory in comparison with other models and about the recent relating experimental results by gas-phase methods will be submitted to JCFRS website.)

Search for advanced simulation model of cascade vortices underbeneath of the electrode surface

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Abstract: During long-term electrolysis for well annealed thick Pd rod (9.0 mm Φ) in 0.1M LiOD, vortex pattern was observed [1-2]. The morphology of the postelectrolysis electrodes revealed the two long faults without any cracks on the surface. N-cycle model was proposed [3-4], where the vortex threads move underbeneath of the surface to understand the CF phenomenon. Further the vortex threads were realized as the continuous flow of hypothetical particles mass from a vessel to a neighboring one in the Scavenger process. So far, we have succeeded in obtaining, though not precise a vortex pattern and their cascade [5]. Mean while we noted that the magnetic configuration underbeneath of the surface layer plays an important role in the simulation of the motion of the hypothetical particles mass flow.

From a different viewpoint, we should focus the physical rules which were found in natural phenomena and apply these ideas to advance our model in PC computer simulation works (3D motion of the hypothetical particles mass). Of particular interest is 'cyclonic vorticiy' [6], namely vortices shown in Fig.1. This view is rather schematic diagram of the fluid stream line appeared in the solar convective zone. It is noted that the solar dynamo (above mentioned research area) is not well investigated solar flare or corona mass explosion but laminar or turbulent flow dynamics of the convective zone existing more inside in the solar rotating system. The rotating spherical entity such as Sun possesses different two magnetic fields, which determine the dynamics of compressive fluid. In this study, we understand solar convection and hydrodynamic dynamo action in terms of the dynamics coupled with the magnetic fields evolved. A comparison between this numerical simulation model and that presented in our study helps us in shedding a new light on the numerical simulation of the motion of the hypothetical particles mass.

References

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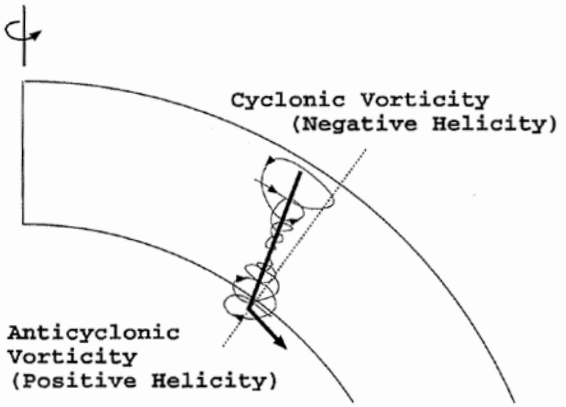

FIG. 21.—Rough schematic diagram of a characteristic, coherent, strong, midlatitude downflow in simulation TUR. Solid lines and arrows illustrate the sense of the flow and the dotted line indicates the radial (vertical) direction for comparison.

5) Mark S. Miesch *et al.*: *ApJ,* **532** (2000) 593

Theoretical study of nuclear reactions in solids using Bose-Einstein condensation model

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Abstract

In our previous work on Bose-Einstein condensation (BEC) approach to the theoretical interpretation of cold fusion [1], we estimated the transition temperature of BEC in palladium deuteride. It was based on the Kim's work [2] by using equivalent linear two-body method to the many-body problems of charged bosons trapped in an ion trap. In the recent work of Kim et al.[3], they have expanded their theory in order to explain the Rossi's experiment [4]. In this study, BEC for the two species case in solids and its transition temperature are discussed by using Kim's theory.

References

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4. S.Focardi and A.Rossi, "A new energy source from nuclear fusion", March 22, 2010. http://www.nyteknik.se/incoming/article3080659.ece/BINARY/Rossi-Forcardi_paper.pdf http://www.journal-of-nuclearphysics.com/?p=66, February 2010

JCF-12 Abs-1 Takahashi

Kinetic Reaction Energy of Cold Fusion

Akito Takahashi (Osaka University and Technova Inc.)

Some essence of the TSC theory consequences on underlying QM physics of fusion reactions in condensed matter is discussed. To attain enhanced cold fusion rate in condensed matter at room temperature, mean kinetic energy of mutual (relative) d-d motion should be elevated as same as the case of hot plasma fusion (typically 10 keV). The mutually high kinetic energy is attained in a deep dynamic (time-dependent) trapping potential of deuteron-cluster in condensed matter. This is required to satisfy the Heisenberg Uncertainty Principle (HUP) of quantum mechanics. Trapped D-cluster in very microscopic domain (ca. 20fm size) behaves like a molecule motion at room temperature gas outside the trapping potential, so that "high temperature" of condensed matter is NOT required.

Procedures for quantitative fusion rate estimations by Fermi's golden rule are explained in combination of the multi-body strong interaction based on the one-pion-exchange potential (OPEP) and the Coulomb barrier penetration in the QM-Langevin equation analysis. Time-dependent total energy of multi-body system settles in local minimum under the constraint of HUP. Using the variational method, mean kinetic energy (expectation value) of d-d pair trapped in the TSC potential was time-dependently estimated with the HMEQPET method, which also gave mean kinetic energies for D_2 molecule and muonic d-d molecule for the comparison purpose.

The Cold Fusion Phenomenon in Hydrogen Graphites

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Abstract

The cold fusion phenomenon (CFP) observed in solid materials with specific compositions (CF-materials) in open, non-equilibrium conditions has been consistently explained by a model assuming existence of neutrons in the materials. The essential factor of the material where realized the CFP is the interlaced superlattices of a host atom and a hydrogen isotope (protium and/or deuterium); one example of the first is Ni-H and another of the second is Pd-D. An exceptional example is XLPE (cross-linked polyethylene) in which a carbon lattice and protium lattice are interlaced by its special structure.

In addition to the systems described above, there are several experimental data on the nuclear transmutation in carbon systems. In these experiments, a lot of iron is produced in addition to other elements such as Ca, Si, V, Cr, Mn, Co, Ni, Cu and Zn when carbon is used as electrodes for arcing in water. Furthermore, it is shown that the isotopic ratios of the generated iron are the same to the natural ones. These generated elements exist abundant in nature as we had pointed out in relation to one of the statistical laws in the CFP, the stability effect of nuclear transmutation products, as shown in Fig. 2.11 of our book *The Science of the Cold Fusion Phenomenon* (2003).

On the other hand, it is well known that graphite absorbs hydrogen isotopes very much as to be nominated as a reservoir of hydrogen. In the case of XLPE, the formation of neutron drops in the cf-matter due to the interaction between carbon lattice and proton lattice is used for the explanation of nuclear transmutations. This mechanism suggests that a similar interaction may exist in the hydrogen graphite where the carbon lattice of graphite interacts with the proton lattice interlaced with the former.

Then, the neutron drops in the cf-matter formed by the interaction between the interlaced lattices facilitate the generation of new elements in hydrogen graphite at a condition of room temperature. The generated elements have, as the stability effect of nuclear transmutation shows, similar characteristics to those of elements generated in celestial conditions. The experimental results obtained in the carbon arcing in water show a possible application of CFP in hydrogen graphite for nuclear transmutation and excess energy generation.

Deuterium desorption test using Ni/Pd multi-layered sample

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We have investigated the low energy nuclear reaction in the deuterium out-diffusion from the multi-layered film sample. In the past study, various types of samples, such as Au/Pd/MnO, Pd/Au, Pd/CaO, Au/Pd/CaO, Pd/Pd, have been examined and we observed the events which could be associated with the nuclear effects. However, the origin of the phenomena has not been specified, and a certain condition to induce the reaction has not been clarified. Thus, the systematic study with various types of sample is still needed. Nickel is one of the interesting materials in the study of the condensed matter nuclear reaction. The events indicating the occurrence of the nuclear reaction have been often observed in deuterium/hydrogen absorbing and desorbing processes with the Ni or the Ni-Pd complex. It is supposed that a specific property of Ni may induce the low energy nuclear reaction effectively. In this study, we performed the deuterium desorption test using Ni/Pd multi-layered sample and searched for the nuclear phenomena. We also tried to characterize the Ni properties in terms of inducing the nuclear effects.

We fabricated the Ni/Pd multi-layered sample depositing the Ni film (~150 nm) onto the Pd foil (10 x 10 x 0.1 mm^3 or 10 x 10 x 0.5 mm^3). Then, the sample was loaded with deuterium by exposure to the 5 atm deuterium gases for 23 hours. The D loaded sample was placed in the evacuated chamber and applied DC current to stimulate the gas diffusion from the sample. The sample temperature and the pressure in the chamber were monitored continuously for 24 hours. The charged track detection was also performed using the CR-39 track detector and the Si-SSD. As the results, anomalous temperature behaviors which could not be explained by the chemical reactions or Joule heating process were sometimes observed. Moreover the tracks indicating the charged track emission were recorded on the CR-39 detector. In this presentation, we discuss the possibility that these phenomena are due to a nuclear reaction.

Change in Isotopic Ratio of Li by Light Water Electrolysis

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A change in the isotopic ratio of any elements can directly imply the evidence of the low energy nuclear reaction(LENR). We have been interested in the change in the isotopic ratio of Li rather than these of other elements. Because mass number 6 of Li cannot overlap with those of other elements and ions. Thus, we have been studied the change in the isotopic ratio of Li for electrolysis using time-of-flight secondary ion mass spectroscopy(TOF-SIMS).

In this present study, we performed DC light water electrolysis of Li_2SO_4 solution for 2weeks using several foil cathodes(Au, Co, Ni, Pd) and Pt foil anode of $0.1\times10\times5$mm in size. The electrolysis cell is made of polytetrafluoroethylene with volume of 100ml. In order to investigate the change in the composition of elements on cathode surface, we prepared the control sample, which was immersed into the same solution for the same period of 2weeks without electrolysis. The cathode surface after the electrolysis and the surface of control sample were analyzed by TOF-SIMS. The primary ion in TOF-SIMS was Ga^+ and measured area was 40×40 micron square. Three randomly selected areas on the surface were analyzed. When the number of produced ions for each element increases considelably, the TOF-SIMS counting number can be less than the produced one. We found that such counting error is small to consider the isotopic ratio in the region of total count less than 2.0×10^5 for ^{7}Li. The isotopic ratio of Li for the control sample as well cathode foils Co, Ni and Pd fairly agrees with that of natural one. To the contrary, a marked change in the isotopic ratio of Li was sametimes observed only for Au cathode after the electrolysis. The lagest change in the ratio(^{6}Li/^{6}Li+^{7}Li) reaches 11.4 from 7.59 of the natural one.

Numerous etch pits on CR-39 produced by light and heavy water electrolysis

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We have been studied low energy nuclear reaction (LENR) during electrolysis[1].In this present study, we perform the electrolysis of Li_2SO_4/H_2O, Na_2SO_4/H_2O, Li_2SO_4/D_2O and $LiOH/D_2O$ solutions under DC current of the order of mA for 168 h. The cathode is a ϕ10 mm and 5μm thick Ni film or a 2.5μm thick Au film. The anode is a ϕ0.5 mm Pt wire. The wire end forms spiral which plane is parallel to the Ni film cathode. The concentration of these solutions is 0.1M. A CR-39 detector chip of 30×30mm in size is set in close contact with the rear surface of the metal film cathode. This construction can avoid contamination from the electrolyte and keep the ideal distance between the cathode and the CR-39 chip. The electrolysis experiment is performed simultaneously with the control experiment.

The CR-39 chip is etched in 6N NaOH for 7 h at 70 degree C immediately after each experiment. Then, the surface of the CR-39 chip is observed to count the number, to measure the diameter and to take photograph of the etch pit using a digital microscope system. Anomalous increasing in number density of etch pit is sometimes observed on the chip for the electrolysis experiment using Li_2SO_4/H_2O, Li_2SO_4/D_2O and $LiOH/D_2O$ solutions. To the contrary, no such increasing is observed on the control chip. The pit is also observed in the small outer area neighboring to the O-ring which serves as a sealing the electrolyte. However, the number density is always fairly same as that in the inner area. These results indicate that energetic charged particles are generated at the Ni film and that a kind of nuclear reactions would occur during the electrolysis.

Reference

1) H. Yamada et al., Detection of Energetic Charged Particle from Thin Metal Cathode in Light and Heavy Water Electrolysis Using CR39; Proceedings of the 11th Meeting of Japan CF Research Society, pp. 41-46 (2010).

Computer Simulation of Hydrogen States in Pd Metal of Face Centered Cubic Lattice

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When nuclear fusion and nuclear transmutation occur in condensed matter such as metals, it will be necessary for two and more hydrogen or deuterium atoms to gather and condense in the narrow domain of it.

In order to examine which kind of conditions cause two and more hydrogen to gather in metal, we simulated the states of hydrogen in palladium metal of face centered cubic lattice using a quantum molecular dynamics on a personal computer. We calculated the total energy, charge density and electronic structure of the host bulk metal by a computer simulation program within Density Functional Theory based on the local density approximation using pseudo-potentials and a plane-wave basis.

Calculations were done first about four hydrogen atoms located on the four O sites beside one T site and about four hydrogen atoms located on the planes of the tetrahedron composed by four Pd atoms around the T site changing the atomic distances of the tetrahedron. The periodic boundary conditions were imposed on the computing 2x2x2 super cell of 28 Pd atoms and four vacancies next to each O site. And calculations were done second about four hydrogen atoms located on the four of eight T sites beside one O site and about others similarly changing the atomic distances of the octahedron composed by the six Pd atoms around the O site. The periodic boundary conditions were imposed on the computing 2x2x2 super cell of 28 Pd atoms and four vacancies next to each T site similarly.

We observed in the first case the total energy of states when four hydrogen atoms located on the four O sites were lower than that of four hydrogen atoms located on the planes of the tetrahedron, and we did not observe those energies were reversed by changing the atomic distance of the tetrahedron longer because the Coulomb repulsion of four hydrogen core of the latter was strong. However, we observed in the second case the total energy of states when four hydrogen atoms located on the four T sites were lower than that of the other states first, and it became higher than that of four hydrogen atoms located on the planes of the octahedron by changing the atomic distance of the octahedron longer. This would mean that four hydrogen atoms located on the four T sites with vacancies could go up to the O site entering into the octahedron when it expanded. But they could not go up together far beyond the planes of the octahedron because the Coulomb repulsion of their core was strong.

Three Laws in the Cold Fusion Phenomenon in Open, Nonequilibrium, Multi-Component Systems

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Abstract

The cold fusion phenomenon is known to occur only in specific systems satisfying several necessary conditions. The most important characteristic, which is sometimes put aside not explicitly taken into consideration, is that the system is open, nonequilibrium, multi-component one.

There have been discovered three empirical laws in the cold fusion phenomenon (CFP); (1) The First Law, the stability effect of nuclear transmutation products, (2) the Second Law, the $1/f$ dependence of the frequency on the intensity of the excess heat production, and (3) the Third Law, the bifurcation of the intensity of events (neutron emission and excess heat production) in time. The three laws suggest that the various events in the cold fusion phenomenon (CFP) in the solid-state nuclear physics, or condensed matter nuclear science, are results of nonlinear interactions between component elements (agents) of the system composed of regular arrays of transition metals interlaced with those of hydrogen isotopes.

We may conclude from these laws governing events in the CFP that the cold fusion phenomenon is induced by nonlinear interactions between agents in the open and nonequilibrium CF systems as a complexity as far as we assume a common cause for various events in the CFP, i.e. excess heat production, neutron emission, and nuclear transmutation.

The characteristics of the CFP, such as the high ratio of D/Pd or H/Ni, higher temperature of the system, occurrence of positive feedback, are investigated using our knowledge of the microscopic structure of the CF materials consulting to the complexity in relation to the three laws explained above.

A computer simulation is proposed to reproduce an essential feature of the CFP using a simplified model system composed of two interlaced lattices; one lattice of hypothetical host nuclei with extended neutron wavefunctions and another of proton/deuterons with non-localized wavefunctions.

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4H/TSC Fusion by Simultaneous Weak and Strong Interactions

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The TSC theory is applied for the 4H/TSC condensation motion and possible weak nuclear interaction in the diminished size state (4H/TSC-min) of 4H-cluster. The 4H/TSC cluster may condense to a very small (in 3fm size) charge neutral entity, because the strong interaction - which works to make 100% fusion for 4D/TSC-min of ca. 20fm size- does not work for the 4H-cluster and therefore the 4H/TSC-min sate may go further into very small size as 3fm. We may expect the kinetic energy of trapped 4 electrons in 4H/TSC-min will reach at around 600 keV (KE) which exceeds the threshold energy (272 keV) of the weak interaction: $p + e^- \rightarrow n + \nu + (KE - 272\ keV)$.
Produced neutron shall make promptly (by 100%) multi-body simultaneous strong interaction with 3 protons existing within the Compton wave length (1.4fm) of charged-pions as interaction force-exchange bosons, to result in the $3p + n \rightarrow {}^3He + p + 7.7$ MeV reaction.

Prediction of fusion rate in Ni-H systems and its secondary nuclear products as neutron (free emission) and gamma-rays is discussed to be very small (10^{-13} order) level. The primary 4H/TSC WS-fusion rate is on the order of 10^{-7} per 4H/TSC generation, which is much smaller than the 1.0 per 4D/TSC case. Discussion is given about conditions in Ni-H systems for enhancing 4H/TSC WS fusion rates to visible heat-power reaction rates.