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Mechanism of Cold Fusion with Nano Metal-Particles and Conceptualized Reactor to Control the Nano-Metal Particle Potential

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Abstract:- Although the nano-metal particles have the high capability to generate the very high excess heat due to the larger reaction site on the nano-metal particle, the mechanism of triggering Cold Fusion with nano-metal particles is not clear so far. In most reactors with nano-metal particles have no triggering mechanism except the heater and conventional heating seems to cause the agglomeration, thus currently composite nano-metals are used in the reactor. In this MHE (nano-Metal Hydrogen Energy) Reactor, the composite nano-metal particles have the excellent heat generation without agglomeration, however its mechanism of trigger of cold fusion and D absorption is not clear so far. Thus, I will explain my hypo of the mechanism of this reactor with composite nano-metal as follows. This reactor has no nano-particle potential control and heating is indirect and insufficient. Because nano-metal particles are embedded in the pores of ZrO_2, nano-metals inside the pore can have the cold fusion without cooling by D_2O, it helps the triggering of cold fusion. Although without electrical connection of nano-metal particle in the pore of ZrO_2, they have the stray capacitance and can have the D^+ current to the capacitance and thus I presumed that it is possible for the limited amount of total ion current by charging the nano-metal parasitic capacitance, and it can create the locally high temperature in nano-particle embedded in pore of ZrO_2. Because nano-particles have the space between its body and pore wall which prevent cooling by D_2O. Because they have the excellent heat resistance to prevent agglomeration so the excess heat generation is excellent.

However MHE (nano-Metal Hydrogen Energy) Reactors have no mechanism of potential control of nano-metal particles Thus, I presumed that this reactor must have the positive potential electrode around particles for D loading, which is probably the heater around particles. Because the heater has the temperature gradient on metal chassis, heater metal can have the potential difference due to William Thomson effect which is that lower temperature region has the negative potential.

Composite particle is excellent to prevent agglomeration of particle due to ZrO_2 property of very high heat resistance, Thus, I propose that new reactor design with nano-metal particle potential control with parallel metal plate, and nano-metal particles are on the flat plate and they can be heated directly by the flat plate with the heater on the backside of the plate.

Other Reactor is for the prevention of nano-metal particle not the composite particle to prevent agglomeration by the charging of the same charge to have the coulomb repulsive force to keep a distance between the particles, enabled by the switching of the metal plate voltage and the location control of particle by ultrasonic oscillator. This Reactor can run Cold Fusion and D loading simultaneously by adjusting the electrode voltage and location of particle with ultrasonic oscillator.

I also propose the transmutation reactor with Cold Fusion with H_2 gas through the diffusion of thin metal layer with H^+ supply from the backside.

Keywords:- *LENR, Cold fusion, neutron, EDO, Electron Deep Orbit, Coulomb repulsive force shielding, transmutation, nano particle Li hydride, Lattice assisted nuclear fusion, Buffer energy nuclear fusion, E-CAT, Lattice confined Fusion, nano metal particle, Composite nano-metal particle, ZrO_2.*

I. INTRODUCTION

In 1989, Martin Fleischmann and Stanley Pons were catapulted into the limelight with their claim to have achieved fusion in a simple tabletop apparatus working at room temperature [1]. Their report described an experiment involving electrolysis using D_2O in which the cathode fused (melting point 1544 ºC) and partially vaporized, and the fume cupboard housing the experimental cell was partially destroyed.

1.1.2 Cold Fusion Overview

I summarized Fleishmann, S. Pons experimental tool [1] and mechanism of cold fusion in ref [2],[3].

Nano-particle is used to improve the heat generation [4],[5],[6],[7]. Nano metal particle is promising to have very high excess heat generation.

1.1.3 Cold Fusion mechanism

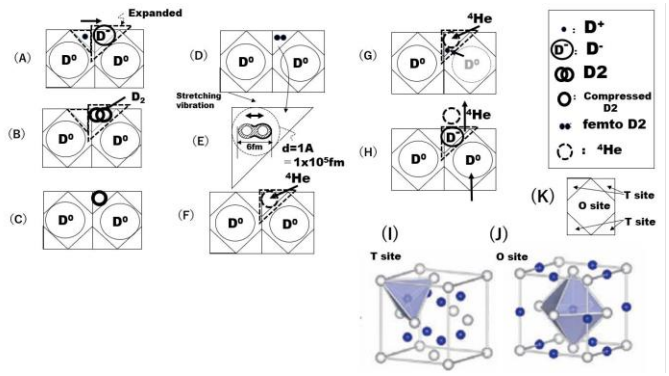


Fig.1. Cold Fusion Mechanism.

I summarize the mechanism of cold fusion briefly and so please read the ref [2],[3].

(A) Cold Fusion starts after D loading inside metal.

D^- at the expanded surface metal due to the electronegativity of the surrounding lattice atoms, which transfer electron to D, which changes D to D- at surface T site and T site is expanded.

(B) D^+ join to D^- to be D_2 at the surface T site, with coulomb attractive force between D^+ and D^- and by the hopping of D^+ to D^-.

(C) D_2 is compressed by the surrounding expanded lattice T site atoms.

(D) Small D_2 is created based on electron deep orbit, explained in ref [2]; small D_2 is the tightly bound d and electron pair, in case of small H is the neutron (tightly bound proton-electron pair in ref [3].

(E) Small D_2

(F) $d+d=^4He$

(G) D^+ move to Surface T site with ^4He

(H) D^+ turn to D^- and expansion to D^- can eject ^4He at the surface T site.

1.1.4 FPE experiment mechanism

I summarize the FPE mechanism as is reported in ref [2]. Because FPE has the opposite behavior to Cold Fusion with the nano metal particle.

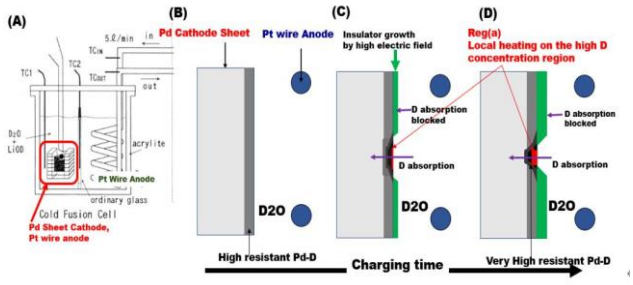


Fig.2. FPE experimental setup.

Experimental reactor of FPE is shown in Fig.2, and note that this is just D absorption with the electrode voltage, and note that Pt wire cage surrounds Pd Rod thus Pd Rod surface has very large electric filed variation and very large surface potential variation on Pd Rod surface.

FPE experimental reactor is just for the D absorption and no triggering mechanisms was not implemented.

Some of other reactor developed after the replication experiment have the better design, however FPE is similar with the reactor with nano-metal particles or FPE experiment is related to nano-metal particle cold fusion.

The experiment used the Pt wire cage to intend to have the uniform electric filed around Pd Rod, however, due to its shape, variation of the electric filed is so large, Pd Rod surface has the inhomogeneous periodic segmentation of insulators grown by the large negative electric filed.

Because Fleishmann and Pons Effect (FPE) is just D absorption under the electrolysis condition in D_2O, and experimental reactor has no triggering mechanism of Cold Fusion. FPE's disadvantage is that insulator layer growth as is shown in Fig.2. Insulator grows under the high electric filed with contamination in D_2O in the reactor, and some researchers is always cleaning before start the experiment can trigger the cold Fusion because of inhomogeneous insulator on Pd Rod surface which can cause the local heating on the region without insulating layer. The higher temperature of metal causes the hopping of D^+ to D^- at the surface T site. It is important to note that Cold Fusion and D absorption is the totally different phenomena, which need to be separately controlled. Especially nano-metal particles have the essential issue about the uncontrolled potential of isolated nano metal particles.

1.1.5 Cold Fusion Reactor requirement

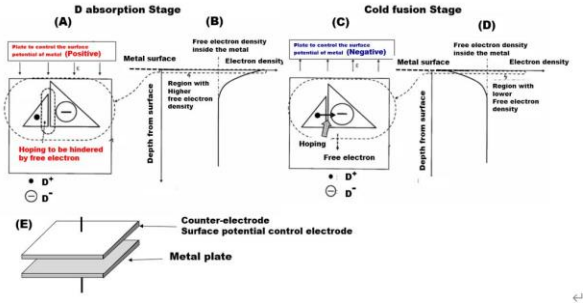


Fig.3. Positive surface potential to reduce the electron density.

It is important to control the surface potential of the metal surface both for D absorption and Cold Fusion, and note that nano metal particles even have not potential control of each nano-particle.

For Cold Fusion reactor with flat metal plate, the metal surface potential needs to be positive for the following cause. Positive surface potential can reduce the electron density on the surface near-region.

One possible cause is that free electrons shield the coulomb attractive force between D^- and D^+ Thus, less free electron density to prevent the coulomb attraction force shielding between D^- and D^+ as is shown in Fig.3.

Because hydrogen has the possibility to be positive, neutral and negative ion; D^x (X=-1,0, +1), depending electronic state around the hydrogen. In case that that metal surface is positive potential, less free electrons there, and such electronic state can induce D^+.

This surface potential effect is yet to be proved by the experiment, so I would like to request the researchers to run experiment on this as is shown in Fig.3 This effect is used in the conceptualized reactor with nano-metal particles.

II. OVERVIEW OF THE COLD FUSION MECHANISM OF NANO-METAL PARTICLES

2.1 reaction site of Cold Fusion on nano-metal particles

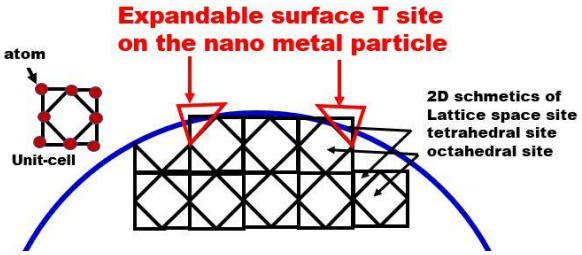


Fig.4. 2-D schematics of nano-particle/roughness size effect of surface T site expansion

In case that nano-particles have the smaller radius, they have the larger probability of T site which adjacent lattice atoms are missing as is shown in Fig.4. Due to the smaller radius of nano-particle or nano-roughness, the number of the unit cell on the surface with adjacent imperfect unit cell unit cells are larger. In case that the surface T site without lattice atoms adjacent to the T site can be expanded as is shown in Fig 4. So, I call it expandable T site. In ref [8], neutron diffraction experiment showed that shell-region (near surface region of nano-metal particle) has the larger number of D occupation.

Under the condition of the same metal weight, nano-metal particle with smaller radius can have the larger total surface area, and the nano-metal particle with smaller radius has the larger probability to have expandable surface T site, so the nano-metal particle with smaller radius must have drastically larger number of the expandable surface T site.

2.2. nano-particle size effect on D diffusion

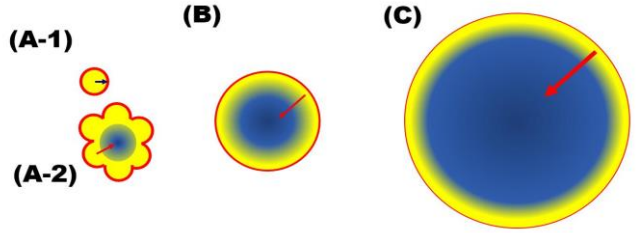


Fig.5. nano-particle size effect on the excess heat generation

As is shown in Fig.5, nano-particles with smaller radius have the faster D charging inside nano-particle than larger particle due to the smaller volume due to the larger ratio of surface area to volume of nano-particles.

Because the diffusion of D^+ to the nano-metal surface starts after the less gradient of D concentration inside the particle as is shown in Fig5(red arrow). Under the same loading time particle with larger radius just have the D near surface region and the diffusion of D is to the inside (red arrow in (A-2), (B), (C)). However, nano-particle with small radius as is in (A), it can reach the uniform D concentration inside the nano-particle faster and the diffusion of D is to the outside. This case D can diffuse to the particle surface (blue arrow in (A)) due to the d concentration near surface region is slightly lower due to the out-diffusion of D.

In conclusion, Considering the size effect on the total number of expandable T site and D diffusion, the total heat generation by the nano-particles with smaller radius has by far larger excess heat generation and shorter time to trigger cold fusion and faster D supply to the reaction surface. Note that volume of nano-metal particle with smaller radius is smaller, the total excess heat generation is lower per one cycle; (D loading to Cold Fusion), thus D loading need to be done with the shorter time and repeat the cycles to increase the total excess heat generation. Because it is important to control the surface potential of the nano-metal particles, thus, let's think about the actual the isolated nano-metal particle potential as is sec 2.3.

2.3 Surface potential control

Most Cold Fusion Reactors with nano-metal particle have no electrodes to control the particle potential. Nano-metal particles are just in the reactor without potential control. To the best of my understanding, the reactor without metal potential control does not have cold fusion.

Thus, I use my model of reactor with two parallel electrodes, which is the standard setting of plasma reactors. I estimate the potential of metal particles in Fig.6.Generally speaking the floating electrode in the electric filed has several types of charging, contact charging, electrostatic induction, Inductive charging.

Under the electrolysis condition, upper electrode is positive and bottom electrode is ground, and the most metal particles have the negative charges by inductive charging, and the contact charging with upper electrode is positive, and electrostatic induction by the upper electrode induce negative charging which electric filed is so high that it can cause the insulator growth, thus we must pay attention to the location in proximity to the upper electrode for D loading condition.

Under cold fusion condition, situation is opposite to D loading, however, the positive charging is needed for Cold Fusion and it is OK to have positive charging, but note that contact charging to the upper electrode cause the negative charging, which hinder Cold Fusion.

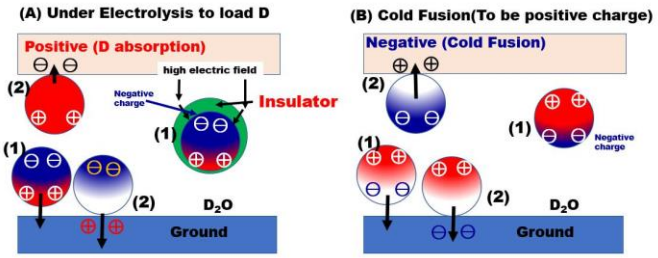


Fig.6. surface potential in the reactor and charging

2.4 Temperature/Potential control

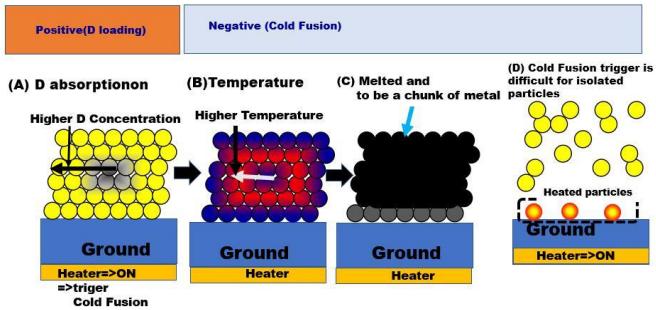
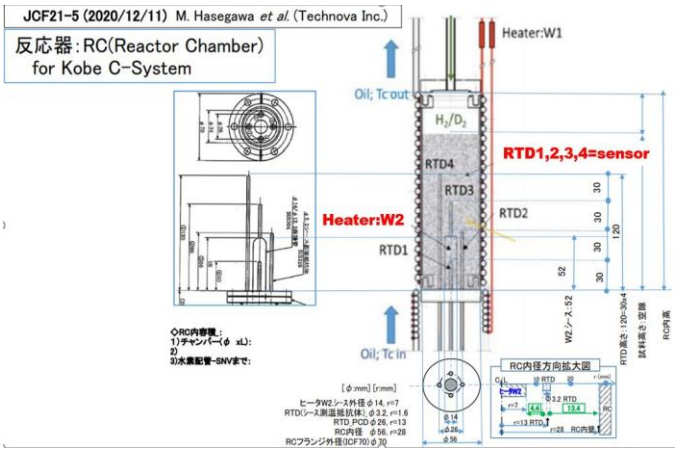


Fig.7 estimation on temperature of the nano-metal particle

In Fig.7(A) is the D loading to all of particles of a chunk of particle because the all of the particle potential are connected to ground during D loading. If the cold fusion occurs on the peripheral particles, the temperature rises toward the center of the chunk of particle and due to the high temperature of the chunk of metal, they agglomerate and it becomes the chunk of bulk metal. This is the serious issue of Cold Fusion of nano-metal particles. Note that isolated particle can not be triggered cold fusion because the temperature does not transfer to other particles. To prevent the agglomeration distance between particles must be wider, however trigger of cold fusion, particle must contact to all the particles. Thus, this is difficult to solve issue, which can be solved by the new conceptualized reactor to control the particle potential.

III. REACTOR OF NANO-METAL PARTICLE

4.1 MHE (nano-Metal Hydrogen Energy) Reactor



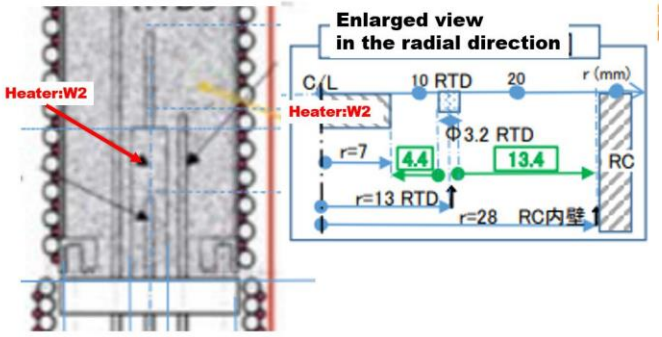


Fig.8. Reactor chamber of C-system in ref [12]

Authors reported in ref [9],[10],[11],[12] the latest results on anomalous heat effect (AHE) by interaction of binary nano-composite metal powders and H (or D) gas, after the NEDO-MHE project (2015-2017), in ICCF22 presentation and paper.

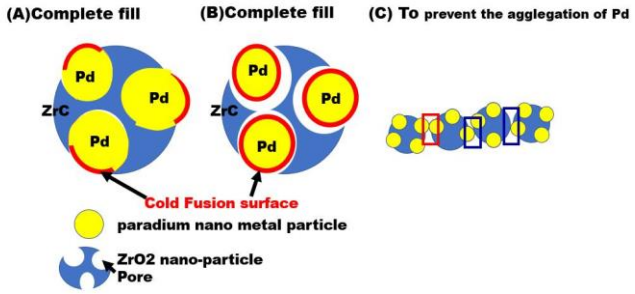


Fig.9. Nano-Composite $PdZrO_2$ to prevent the aggregated bulk Palladium

4.2 Mechanism of MHE Reactor

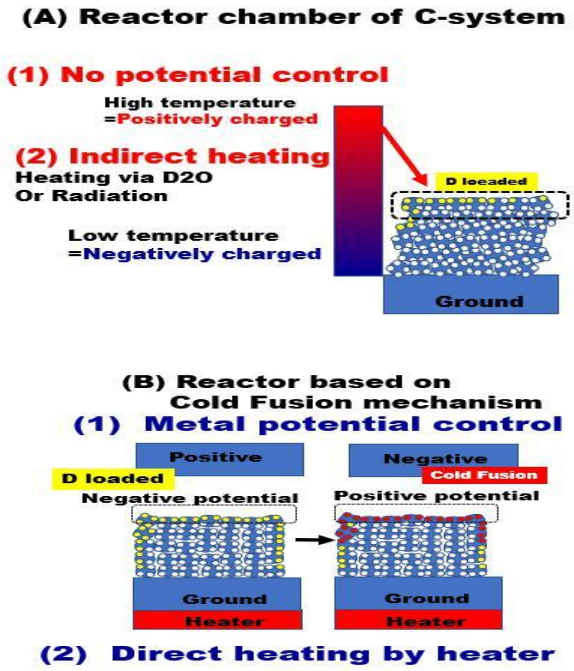


Fig.10. (A) Mechanism of Composite nano-metal Cold Fusion in ref [12] based on affected by the heater potential variation based on William Thomson Effect

(B) conceptualized Cold Fusion Reactor based on Cold Fusion mechanism.

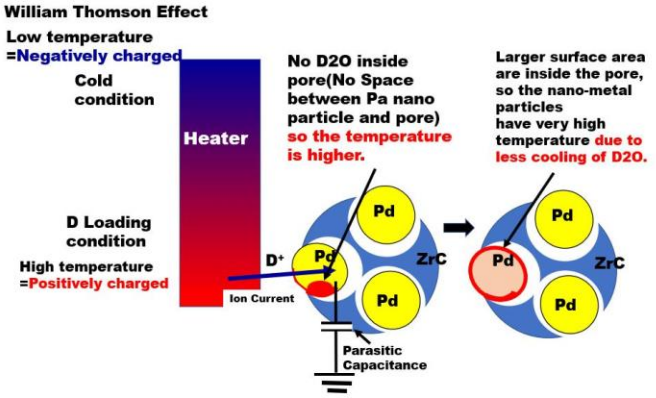


Fig.11 Mechanism of the trigger of Cold Fusion.

In ref [9],[10],[11],[12], Neither specific voltage nor electric field control mechanisms are shown in these references, as is shown in Fig.8, thus, I guessed that the mechanism of Cold Fusion in this reactor is shown in Fig.11(A).

it must be based on the cold fusion mechanism as is shown in Fig.11(B), and to the best of my knowledge, there are no reported reactors with metal particle to have the mechanism of potential control. However at least D loading is under electrolysis condition, and the voltage of the counter electrode is anode and the metal is ground. Thus, there must have the metal with potential in the reactors, and I conclude that the heater can affect the nano-metal particles' potential due to the William Thomson Effect; that metal with higher temperature region and lower temperature region can have the different potential as is shown in Fig.11(A); lower temperature is negative charge, higher temperature is positive charge. And I think this can affect the D loading and trigger of cold fusion as is shown in the Fig.11(A). In Fig.11(A) heating is not direct, so it has the very low efficiency to trigger cold fusion.

As is shown in Fig.8 MHE C-system reactor has the heater W2, adjacent to particles, and particles are probably on the reactor body(grounded) and the heater can have the positive potential due to the higher temperature region as is shown in Fig.10. The particles on the peripheral region facing to the heater with positive potential can have D loaded assuming the metal particles are connected to ground. But actually, composite nano-metal particles have the structure shown in Fig9, it is clear that no electrical connection of nano-metal particle embedded in the pore of ZrO_2.I presume that although the total amount of ion current is so limited, it can cause locally high temperature region in nano-metal particle due to its structure shown in Fig.11 because nano-metal particle has the space between its body to the wall of pore, where no cooling by D2O.The total current can be caused by the charging of parasitic capacitance of nano-metal particles, no ground is needed in this case.

In this experiment [12], no detailed information in the reference, so I would like to request authors to study the mechanism of Cold Fusion trigger of composite nano-metal, because it is promising to generate the very high excess energy but further improvement and stability of operation need to understand the mechanism of cold Fusion trigger.

Authors used Pd Nano-Cluster in Nano-Composite $PdZrO_2$ in ref [10], to have the better hydrogen absorption efficiency than bulk Pd. As is shown in Fig.9, the composite particle works to prevent the agglomeration at the expense of D loading and Trigger of Cold Fusion. Thus, I propose to use the conceptualized Cold Fusion Reactor with composite nano-metal particle, which can charge the all of the nano-metal particle in the pore of ZrO_2.

4.2 Conceptualized Reactor to prevent aggregation by the control the potential of nano-metal particle

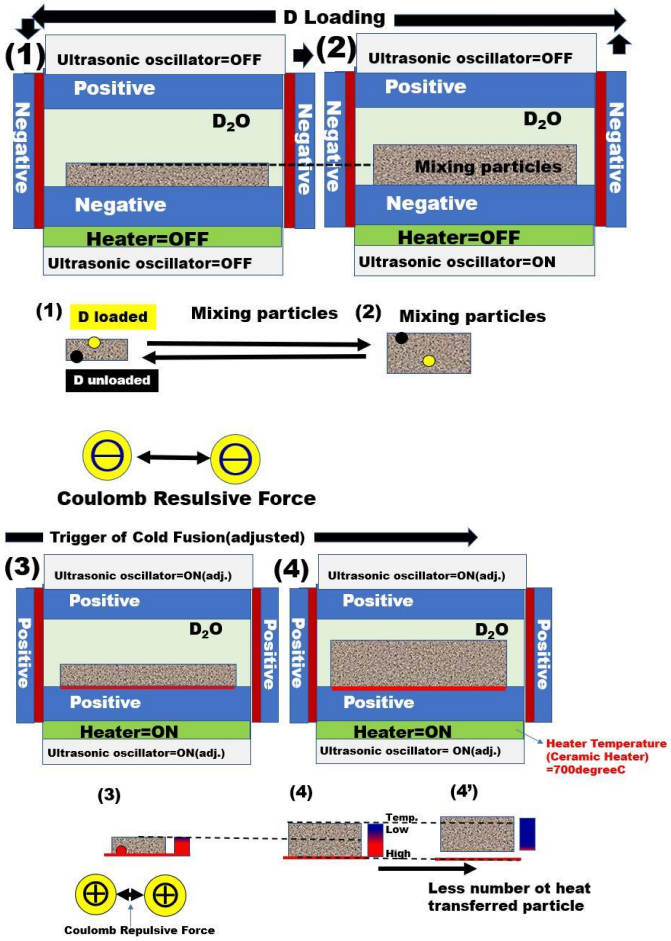


Fig.12. Conceptualized Reactor to control the nano-metal particles' potential control to be negative for D loading, and to be positive for Cold Fusion

As is shown in Fig.12, I show the possibility to keep particles distance as far as possible by direct charging nano metal particle. For D loading negative charge in nano-metal particle and negative electrode can load D into nano-metal effectivelyFig.12(1)-(2), and the negative charges can keep distance between particles as far as possible by the coulomb repulsive force to make D loading easier and faster due to the wider distance between particles, and oscillator can mix the particle on the bottom electrode in D2O, and can have the efficient D loading. As is shown in Fig12(1)-(2). Cold Fusion

can be adjusted by the location of particles as is shown in Fig.12,(3),(4). The location can be adjusted by ultrasonic oscillator parameters to change the location of particle, and it is important for particles to contact to the electrode, because D_2O is lower than 100degreeC. Heater temperature can be as high as 700defreeC, so the particles to contact to the electrode can trigger cold fusion and for this case coulomb repulsive force between particle can prevent agglomeration. The ultrasonic oscillator can be adjusted to move particle to upper to reduce the number of particles with cold fusion as is shown in Fig12(3)-(4)

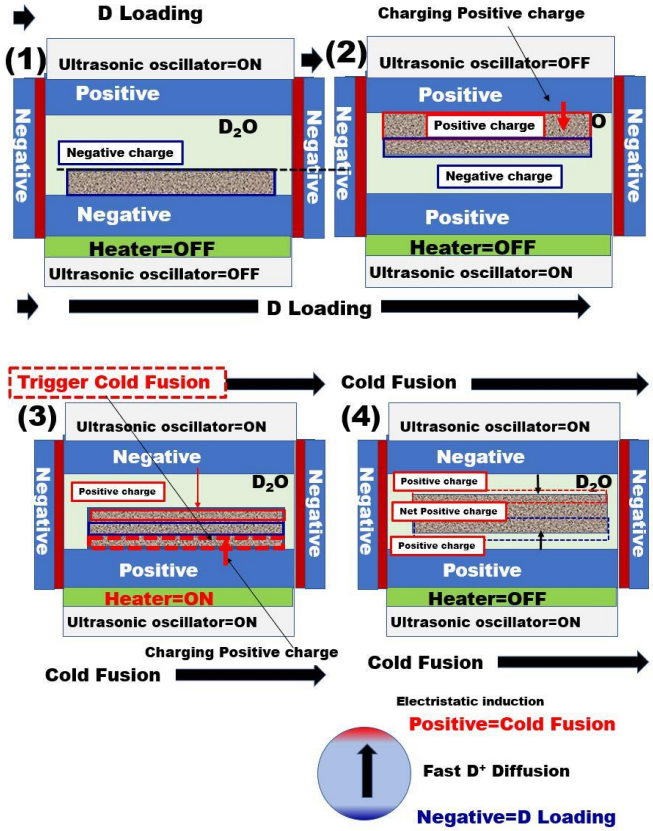


Fig.13. Conceptualized Reactor to run Cold Fusion and D loading continuously and simultaneously

In Fig.13, (1) initially D loading from D_2O by putting particles on the bottom metal plate under the electrolysis condition, and (2) particles contact to the upper electrode of positive potential and particles are charging positive charge and (3) moved the nano-metal particle on the bottom electrode to charge positive charge, and to trigger cold fusion by the direct heating on the bottom electrode. (4) Continue cold fusion in self-sustaining mode under the cold fusion condition for particle having positive net charge and simultaneous D loading from the backside of the particle with their floating in D_2O by ultrasonic oscillator adjustment, and this cycle(1)-(4) can be repeated to continue Cold Fusion.

IV. TRANSMUTATION REACTOR

5.1.1 Transmutation reactor with D_2 gas

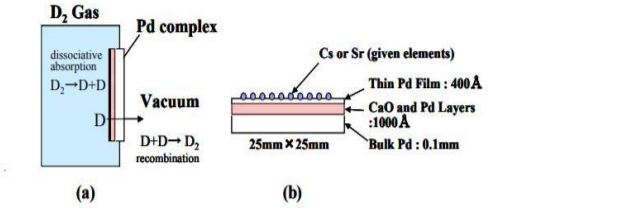


Figure 1. Schematic of the present method: (a)D2 gas permeation of the Pd complex, (b)Structure of the Pd complex deposited with Cs or Sr

Fig.14. Transmutation in ref [13].

(a)D_2 gas permeation of Pd complex (b)Structure of the Pd complex deposited with Cs or Sr.

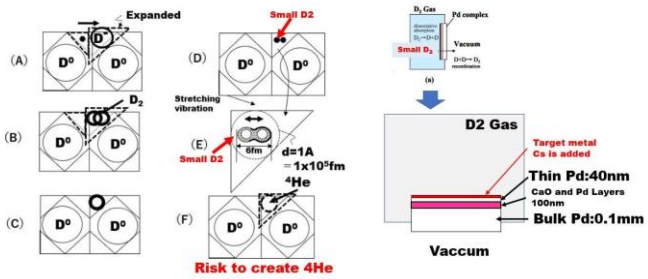


Fig.15. Mechanism of transmutation with D_2 gas and actual reactor configuration based on the report and theory of cold fusion.

Iwamura et.al. studied transmutation by cold fusion with D_2 gas in ref [13].

Authors think that low energy nuclear reactions induced by D_2 gas permeation through Pd complexes (Pd/CaO/Pd) can transmute the Cs on the surface of Pd complex, and Pr emerged on the surface while Cs decreased after the Pd complex was subjected to D_2 gas permeation as is shown in Fig 14. However, this figure may be incorrect because of the configuration of Pd complex. I think that Fig.15 is the correct because CaO is to stop the D_2 diffusion into bulk Pd, and target metal is deposited on thin Pd on CaO, so D absorption in thin Pd can diffuse D_2 from there to the reaction surface where target metal is. Based on my Cold Fusion theory, small D_2 is created at metal surface T site and it can be stable without fusion if the temperature is sufficiently low.

Based on my cold fusion theory, this reactor has disadvantages.
(1) Risk of Cold Fusion to increase the temperature and less small D_2 emitted from the reaction surface.
(2) Due to the high coverage of target metal on thin Pd, it prevents D loading into thin Pd layer.

Thus, I propose the new reactor in Fig.16.

5.1.2 Conceptualized transmutation Reactor with H_2 gas

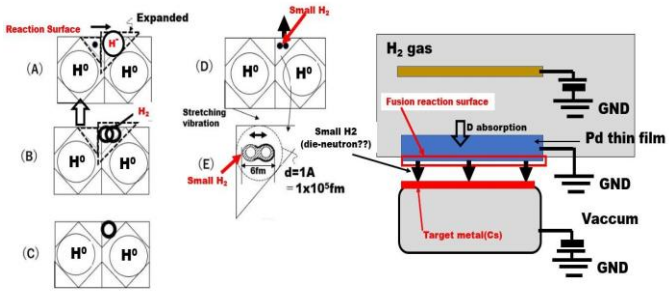


Fig.16 Reactor for transmutation with H_2 gas supply from the backside and potential control of surface and backside potential to create small H_2

Thus, I propose to use H_2 gas loading from the backside through very thin Pd layer to create small H_2 on the reaction surface as is shown in Fig,11. This has the advantage of no fusion reaction to ^{4}He in case of D_2.

It is necessary to control the surface potential of metal for D absorption and Cold Fusion. Target metal can be placed under the reaction surface in proximity.

I think that small H_2 has the similar property of die-neutron, which is a virtual particle composed of two neutrons, is suggested that it is generated from a helium nucleus in a nuclear reaction and exists temporarily. It collides with other nuclei and protons, does not change the atomic number, but increases the mass number by two. However, this die-neutron theory is not based on electron deep orbit theory and, theoretical research shows that it is impossible to generate die neutron, so further theoretical and experimental studies are needed. This transmutation reactor can produce ^{3}He by introducing D_2 gas and H_2 Gas simultaneously, for example D_2 from backside and H_2 in front side, and resulted ^{3}He can be selected by mass spectrometer.

V. SUMMARY

I found the clue to understand the mechanism of triggering Cold fusion of the Reactor with composite nano-metal particle, which is the possibility of potential difference of the heater metal body based on William Thomson effect; lower region has negative potential, however nano-metal in the ZrO2 is in the pore of ZrO_2, Although they have no connection to ground, it is possible for the limited amount of total ion current ion to create the locally high temperature region in nano-particle because nano-particle has the space between its body and pore wall where no D2O is, so the mechanism is the same as FPE, local heating regions trigger Cold Fusion.

I propose the reactor with nano-metal particle with potential control to keep the distance between particles as far as possible by coulomb repulsive force by the particle charge by the contact of the electrode with ultrasonic oscillator, which can control the location of nano-metal particle in D_2O by floating particles.

ACKNOWLEDGMENT

I would like to thank Vavra Jerry and Jean-Luc Paillet for useful discussions on EDO.

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