Novel Cold Fusion Reactors based on the real Cold Fusion Mechanism

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Abstract

I review my Cold fusion theory as described below, and I also propose the experiment to prove hydride bond compression theory based on the currently available reactors and propose the conceptualized Cold fusion reactors based on the cold fusion mechanism.

(1) Cold fusion occurs at the metal surface T site by the compression of D_2 from the surrounding lattice atoms.

(2) Compression of D-D bond can create the small D_2 based on the electron orbit theory, which has been proved experimentally and theoretically.

(3) Bond compression is the common mechanism for the successful cold fusion reactors.

(4) The reactors of Buffer energy nuclear fusion and E-CAT with Li-H utilize the bond compression of Li-H and created small hydrogen (tightly bound proton-electron pair) and Lattice Confinement Fusion utilize the bond compression of Er-D and create small D (tightly bound d and electron pair).

(5) Because both E-CAT with Li-H nuclear reaction and Lattice Confinement fusion of Er-D have no mechanism of bond compression, their reactions can be unstable and irreproducible.

(6) I propose that Lattice Confinement Fusion reactor will be used to prove the mechanism of bond compression to produce excess heat because it seems to be designed to prove the lattice confinement fusion because the transmuted element seems to be stable and it is easy to compress Er-d films by mechanical stress.

(7) I propose the conceptualized Cold Fusion Reactor with nano-metal particles which potential is controlled by the metal 2 parallel electrode, and location of nano-particles can be mixed by ultrasonic oscillator to vibrate nano-metal particle in D2O to get the uniform reaction of D absorption and cold fusion.

(8) Li-H bond can be compressed effectively by the collision of nano Li-H particle by ultrasonic oscillator vibration of Nano-Li-H particle, and can be compressed by 2 parallel metal plates directly This direct compression can be applicable to Lattice Confinement Fusion, however the efficiency is low due to the reaction of D to Er.

I also propose the conceptualized Cold fusion reactor for transmutation with metal surface for Cold fusion to create small H2 and backside potential control for H absorption with H2 gas in place of D2 gas to prevent the heat generation because small D2 can be reduced by D+D fusion.

Keywords: LENR, Cold fusion, neutron, EDO, Electron Deep Orbit, Coulomb repulsive force shielding, transmutation, nano particle Li hydride, SO(4), Lattice assisted nuclear fusion, Buffer energy nuclear fusion, E-CAT, Lattice confinement Fusion

1. Introduction

1.1.1 Background

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 and Fleishmann and Pons Effect Overview

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

(1) Fleishmann and Pons Effect (FPE) is just D absorption under the electrolysis condition in D_2O, and no triggering mechanism of Cold Fusion, as is explained in ref [2].

(2) Cold Fusion is caused by small D2 which is explained by electron deep orbit theory. This theory is not standard theory of nuclear physics however it must be implemented in nuclear physics. [3]

(3) Nano-particle is used to improve the heat generation [4],[5].Nano metal-particle is very important because nano-metal particle is promising to have very high excess heat generation.

(4) Excess Heat generation occurs on the surface rather than bulk.

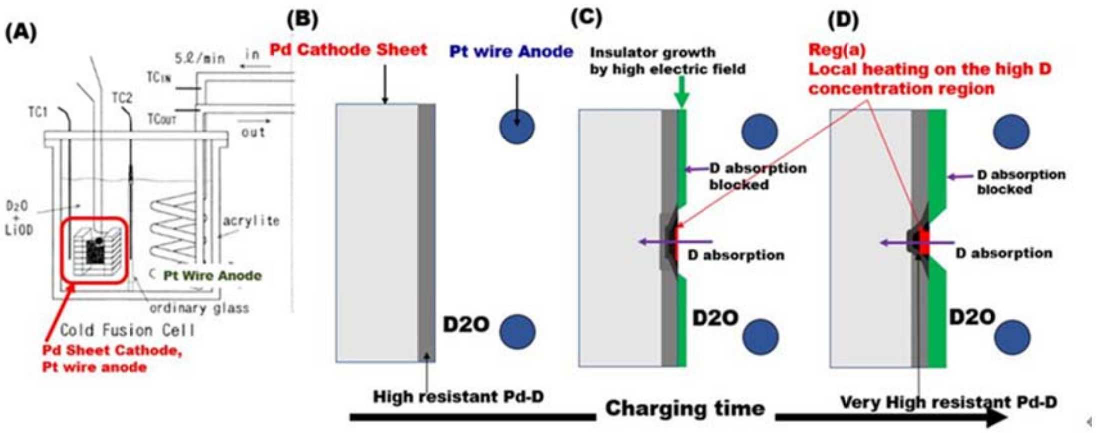

Fig.1 Fleishmann and Pons experimental tool and its mechanism to trigger Cold Fusion

(A) Experimental setup (B)->(C)->(D)increase of D concentration in Pd Rod, and insulator thickness.

Due to the tool configuration of Pt wire cage, it causes very large electric filed variation on Pd Rod. Very high electric filed grows insulating layer on surface of Pd Rod and insulator cuts the current path so the current concentrates on the area without insulating layer, and cell-voltage increases and the larger current flows into the area without insulating layer and temperature there becomes so high to trigger cold fusion. Thus, trigger of Cold Fusion in FPE happens to occur after the very high-density D loading into the Pd Rod. Because the most replication experiments used the same configuration as original FPE tool, so the reproducibility was very low.

Although most cold fusion reactors have been developed without understanding FPE and real Cold Fusion mechanism, a lot of good Cold Fusion reactors are available now. Thus, it is very important to understand the real mechanism of these cold fusion reactor which can generates high excess heat.

1.1.3 Lattice confinement theory and Coulomb repulsive force shielding

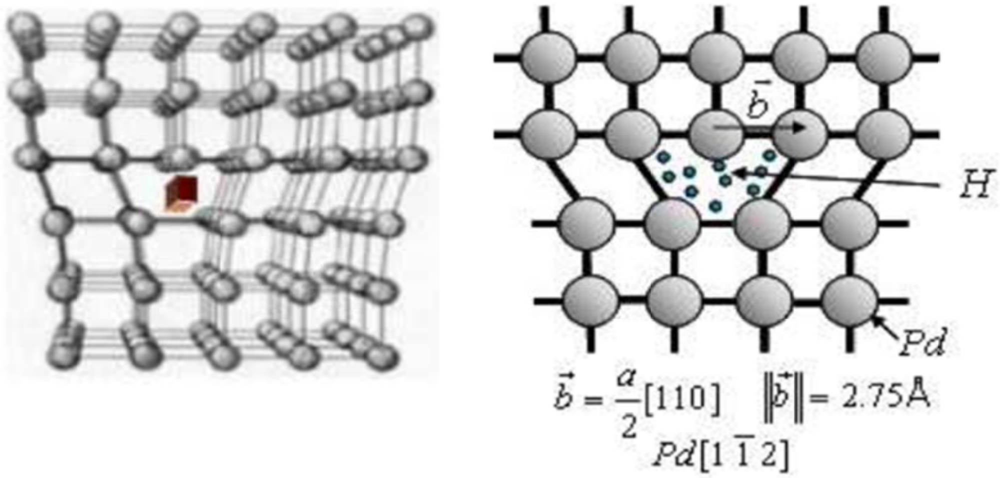

Fig. 2. Scheme of edge dislocation loops in Pd containing condensed H/D.

At the initial stage of FPE replication experiments, most of researchers proposed that the lattice confinement can cause the fusion for example as shown in Fig. 1 [6]. The authors developed a technique for embedding ultra-high-density deuterium clusters (D clusters) into Palladium (Pd) thin film and suggested that hydrogen in ultra-high-density clusters is confined in the dislocation which is created by a very high stress inside the metal and some researchers assume that Cold Fusion reaction has the special state Rydberg matter [7]. However, in reality, the Rydberg matter is created by a laser pulse on a hydrogen-like atom, therefore, that technology is different from cold fusion.

All the similar confinement theories are based on the experimental evidence that a very high D/Pd ratio is required for FPE. Therefore, it would be reasonable assuming that so close d-d distance is possibly caused by the internal force in metal, therefore there are similar theories explaining the ultra-dense D clusters are related to the confinement in dislocations, defect or in lattice space. However, the estimation of the required force shows that according to the simple lattice confinement theory the d-d distance cannot be reduced to the fusion distance by external force as explained by Yu Fukai [8] as explained below.

To enable fusion, the distance between the nucleons should be shorter than the fusion distance (0.1-1 pm), so the Coulomb repulsive force at the fusion distance of 1.5 pm is calculated to be 1×10^{-6} N. However, the elastic induced stress in Pd is estimated to be at least two orders of magnitude smaller than that based on the Pd elastic constant. For example, as a typical internal stress in a metal is on the order of 10 GPa, the pressure applied to hydrogen atom can be estimated as 1 GPa = 10^9 N/m^2 = 1E-9 N/nm^2 = 1E-11 N/Å^2. Therefore, the 1E-6 N force needed to cause fusion is by 2-4 orders larger than the possible internal force in the metal estimated above.

Thus, the Metal lattice cannot provide the compression needed to shorten d-d to fusion distance, and another proper mechanism of Coulomb repulsive force shielding should be involved.
Therefore, I selected the non-standard model of hydrogen electron orbit based on electron deep orbit theory which provides a possible answer as explained in section 2.1 and 4.1.

2.1 Overview of the Cold fusion mechanism

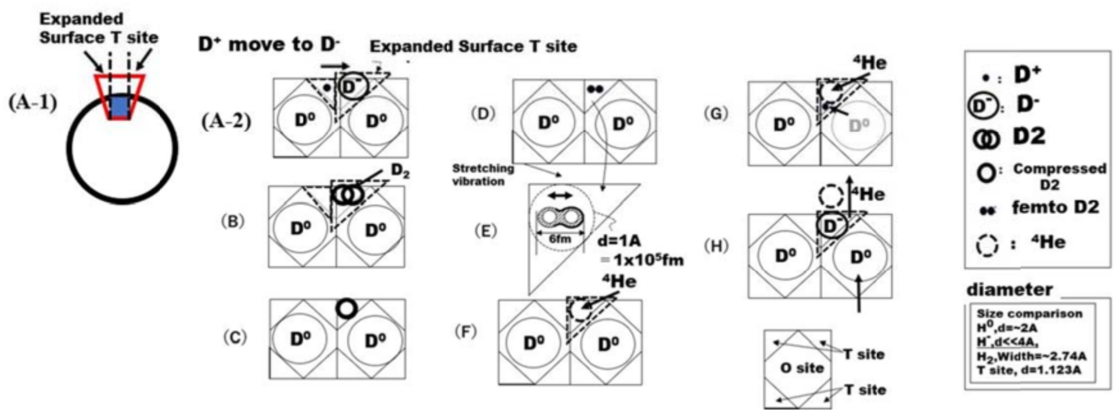

Fig. 3. Proposed Cold fusion mechanism in ref [2].

(A) D^- in a surface T site and D^+ in an adjacent surface site. D^+ at surface T site tends to move to D^- at surface T site.
(B) T site occupied by D^- with subsequent D_2 formation by the hopped D^+ to T site occupied by D^-.
(C) D_2 compression.
(D)(E) D_2 transforms into a small D_2 with EDOs based on EDO theory.
(F) ^{4}He forms due to cold fusion.
(G) ^{4}He is ejected from metal by occupying another D- at surface T site.
(H) D^+ turns into D^- to eject ^{4}He, and D^0 fills the unoccupied O site.

The neutron powder diffraction analysis in [9] shows that D atoms are located at the tetrahedral (T) sites in addition to the octahedral (O) sites of the surface-near location. As is shown in Fig.3 (A-1), (A-2), after the loading of D into the metal, D occupies surface T site due to the easiness of the expansion of top layer metal atoms due to no atoms in the upper region as is shown in Fig.3 (A-1).
I published report in ref [2] on the mechanism of Cold Fusion here I will summarize here.
The idea for the mechanism of Cold fusion presented here arose from the reviews on hydrogen property in the metals and on EDO theory for complete Coulomb repulsive shielding in ref[3], and research on metal hydrides, which together allude to hydrogen behavior in metals being the key to the occurrence of Cold fusion. A surprising fact that almost all Cold fusion phenomenon has been observed in *fcc* (and *hcp*) transition-metal hydrides and deuterides is mentioned in [10]. Because *fcc* and *hcp* have the closest packed structures this indicate that the Cold fusion could occur at the surface T site occupied by D^-; T site is the narrowest site in fcc and hcp.

Because the D absorption and Cold fusion must proceed under the different conditions, let's start with the stage when hydrogen storage is finished in Fig. 3

The hydrogen nature in metals is explained in [11]-[21], and I would like to summarize here the nature of hydrogen in metals illustrated by Fig. 3. Hydrogen is H^0 at O site in Fig. 3, however, strictly speaking, hydrogen can be positive, neutral, and negative ion, depending on the electron exchange with the surrounding electronic state. In case of Hydrogen at T site, Hydrogen is negative (D^-) because it accepts the electron from the surrounding metal atoms due to their electronegativity. Due to the size difference between D^- and T site

The recent theoretical calculations of the electronic structure of metal hydrides performed, founded by Switendick, have shown that both the H^+ or H^- models capture only one aspect of the facts [13]. Based on these features of hydrogen in metals it may comprise positive, neutral, or negative ion meaning that hydrogen has the resonance state between H^- to H^+. Therefore, the diffusion and status of hydrogen in the interstitials in metals need to be interpreted with the resonance, namely the charge of hydrogen can vary from negative (-1) to positive (+1) depending on the surrounding electronic state.

D can occupy the surface T site as D^- with the high priority due to the elastic surface lattice atoms on the surface as is shown in Fig. 3(A-1), (A-2).

2.2 Compression of D-D bond to create small D_2

The compression of D_2 is explained in Fig. 3(B-C). Based on the geometry of the *fcc* lattice parameters and the hydrogen ionic radius, the T site lattice atoms compress the D_2 molecule to make the d-d distance shorter by the compression of the D_2 covalent bonding. The D_2 molecule stretches and vibrates indicating the elasticity of covalent bonding. However, the force keeping the d-d distance at fusion distance is large enough to prevent this. Thus, the proper Coulomb repulsive force shielding is needed to for the fusion. This can be achieved following the theory of Electron Deep Orbit (EDO) explained in section 4.1

3.1 Parameters/Mechanism for cold Fusion reactor

This section is the summary in ref [2]. I think the requirement of parameter of the reactor based on the cold fusion mechanism is explained here.

3.1.1 METAL surface potential Control

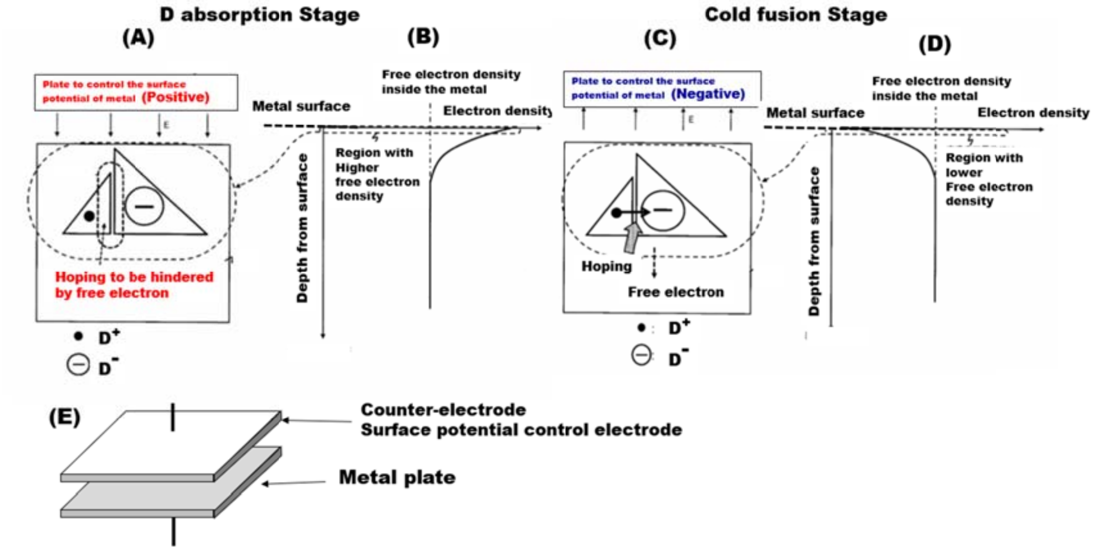

Fig.4 Proposed Cold Fusion Reactor to adjust the metal surface potential.

Metal surface potential need to be positive for Cold Fusion and negative for D absorption.

3.1.2 METAL surface potential Control D absorption and Cold Fusion separately

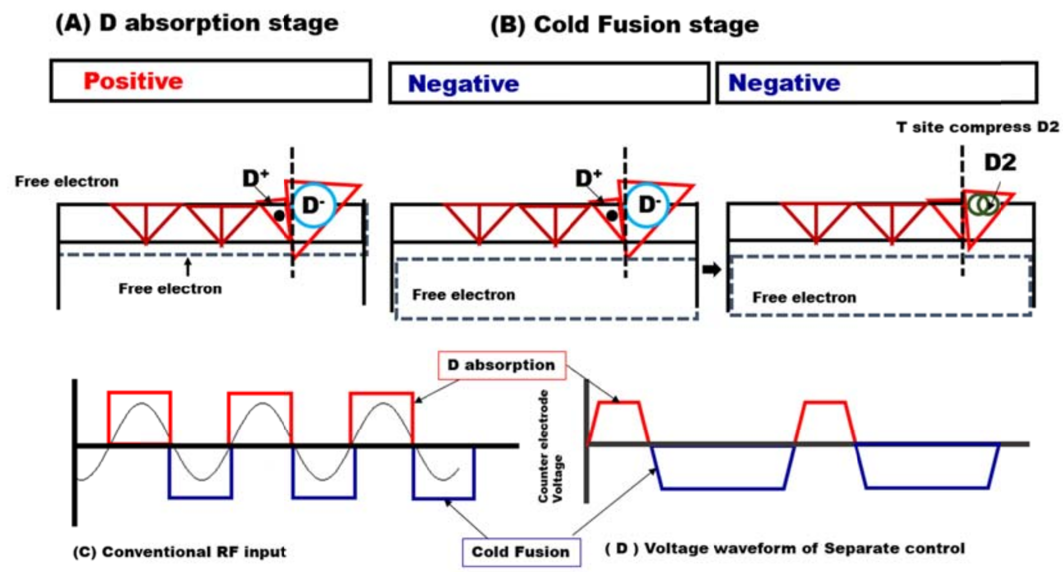

Fig.5 Potential control for Cold Fusion in RF Plasma and D2O electrolysis: (A) D absorption and (B) ColdFusion stages; (C) Conventional RF plasma (RF Input) voltage waveform; (D) Proposed Separated control of (A) D absorption and (B) Cold fusion.

Metal surface potential needs to be adjusted separately to have better heat generation efficiency. This switches D absorption and Cold Fusion and so the proper condition setting can improve the heat generation.

3.1.3 The D supply from the backside of the reaction surface to eject ^{4}He

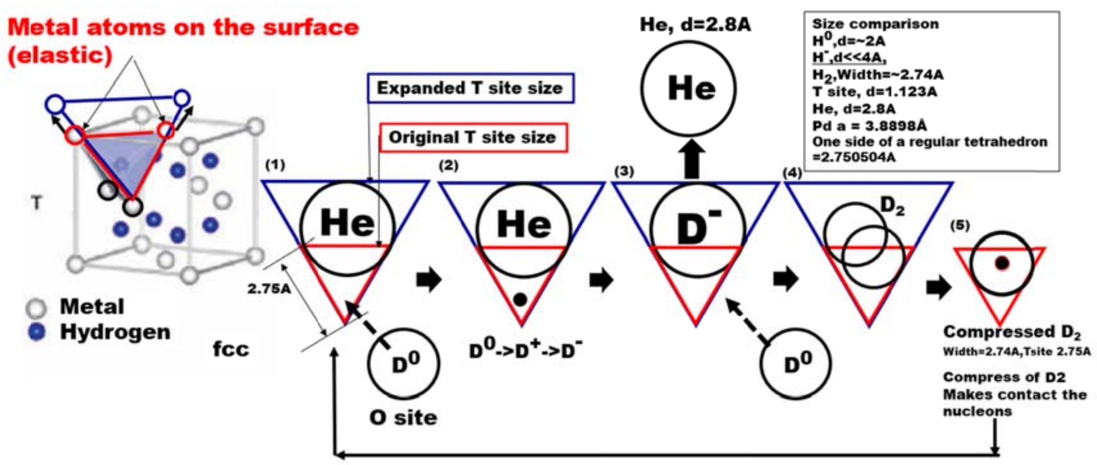

Fig.6 Mechanism of ^{4}He ejection from a surface T site

Without proper control of D absorption and Cold fusion, the remaining ^{4}He ash at the surface T site hinder D absorption from the metal surface. Thus, it is by far better to supply D from the backside of the reaction metal.

3.1.4 Requirement of metal plate structure

With Surface nano roughness and thinner D metal film layer

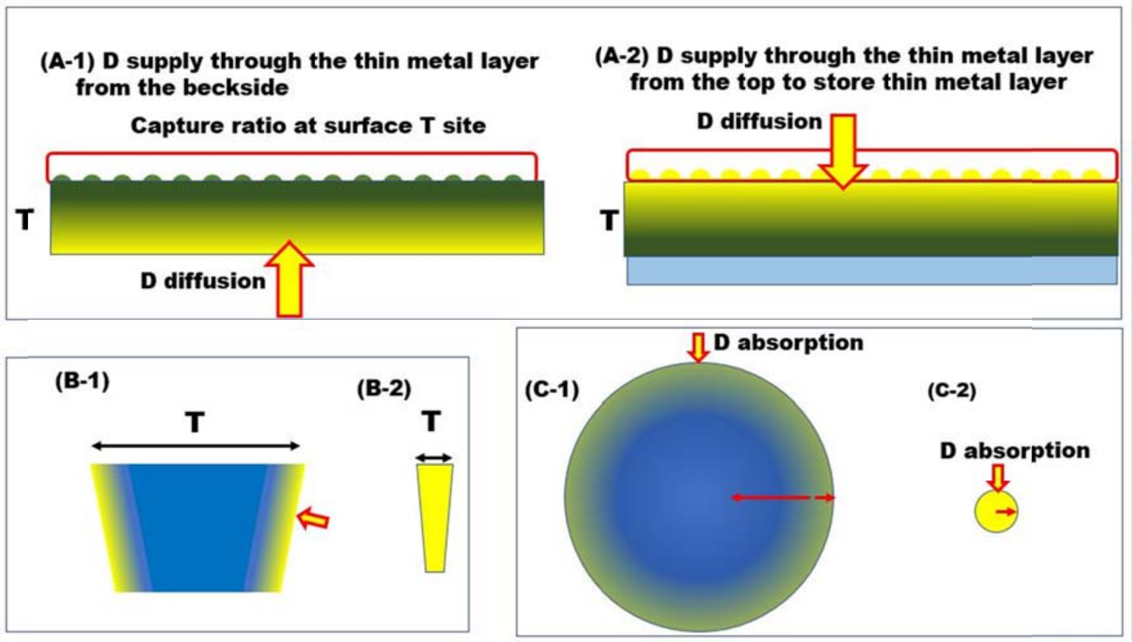

Fig.7 Requirement for metal structure to generate high excess heat

Metal electrode size is very important parameter so I discuss here.

Researchers are surprised at the very high spiky heat generation Fleishmann and Pons Effect (FPE), however actually average heat generation is low because of longer D loading time.

This is very important to understand the mechanism of FPE. Very high heat generation is caused by the very high concentration of the bulky Pd Rod which means that the heat generation speed is determined by the D supply to the reaction surface, and issue is very long D absorption time. Because the total excess heat generation is determined by the D supply speed to the reaction surface and capture ration at surface T site and total surface area. (A-1) is the supply of D from the backside of the thin metal layer so it can eject ^{4}He ash at the surface T site as is shown in Fig.6 and thinner metal layer enable the faster diffusion of D to the reaction surface. Although it has the limitation of actual structure due to the fragility of very thin metal layer, I think that it is worth developing due to the possibility to produce high excess heat efficiently.

(A-2) is the typical way of D absorption from the metal surface into the metal layer, and thin metal layer is also needed for the faster storage of D inside thin metal, because denser D is needed to diffuse D onto the metal reaction surface.

Comparison between (B-1) and (B-2) is easy to understand the FPE, because originally very far Pd Rod was used for the experiment, however lately thinner wires or Rods, are used for the faster storage of D inside. Larger amount of D stored in the larger volume of Pd Rod can generate very high excess heat. Thus, it can improve the efficiency to consider this mechanism deeply. My thought is that (A-1) is better than other metal plate reactor.

Another possibility I think is promising is that nano metal particle can enhance the heat generation drastically because basic mechanism is very promising as follows. the nano-metal particle case (C-1), (C-2), smaller nano metal particle size is critical to high excess energy, and due to the smaller size, cycle of D absorption and Cold fusion need to switch properly and swiftly as is shown in Fig.5, to optimize the total excess heat generation. Because smaller nano metal particle has very high occupation of D at the surface T site with very high D capture probability, and the total number of T site occupied by D is larger foe the same weight of nano-metal particle, so it is very important to optimize the tool configuration, and especially potential of nano metal particle has not been controlled, which is very important for the cold fusion and D absorption as is shown in Fig.4 and Fig.5.

4.1 Electron Deep Orbit (EDO) theory

4.1.1 Background of EDO

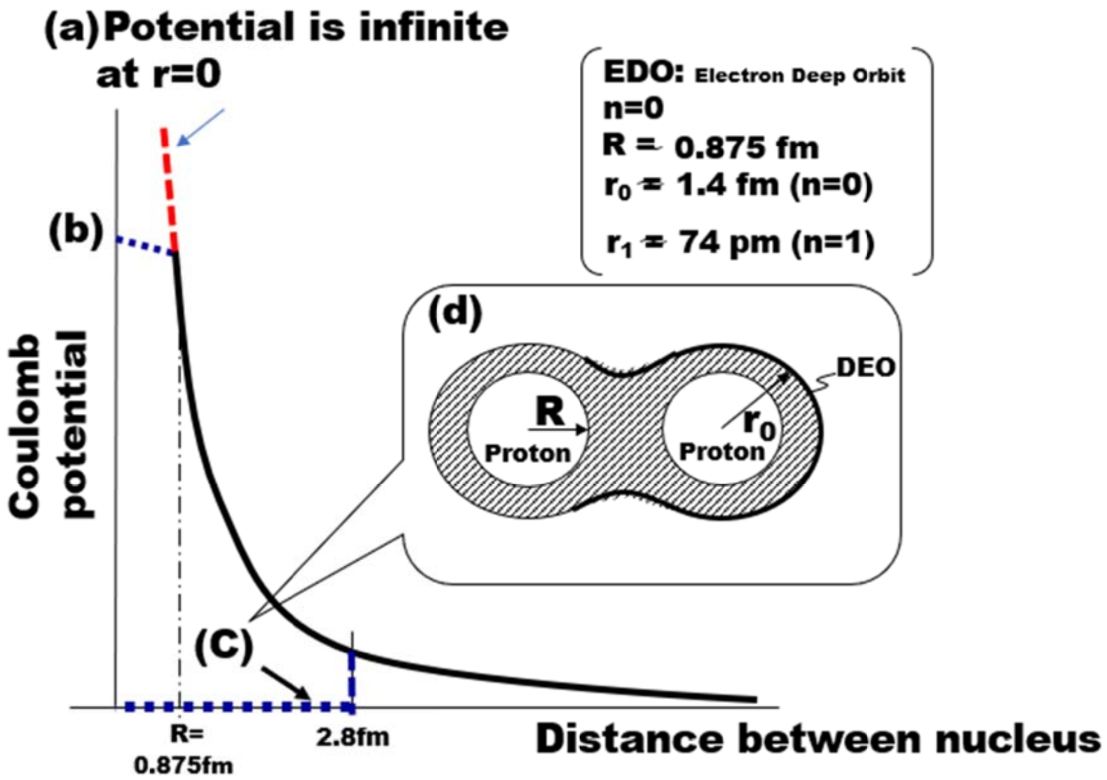

Fig. 8. Coulomb potential of small hydrogen with EDO.

A good summary of the history of the neutron is provided in the introductory section of Va'vra's research [22].

In the 1920s, when quantum mechanics was not yet established, there was an internal electron theory that the atomic nucleus is constituted by protons and electrons. Rutherford suggested in 1920 that an electron and a proton could be bound in a tight state [23]. Rutherford experimentally confirmed the existence of atomic nuclei in 1911 and attracted attention [24]. In a lecture given at the Royal Society of London in 1920 [25], Rutherford predicted that the particles that constitute the nucleus include neutral particles, with almost the same mass as protons in addition to protons.

He asked his team, including Chadwick, to search for this atom, and 12 years later, Chadwick discovered neutrons [26,27], as Rutherford expected. In response to their discovery, Dmitri Ivanenko changed his conventional view of the structure of the nucleus, saying, "Only neutrons and protons are in the nucleus and there are no internal electrons" [28].

Heisenberg also supported this, and his trilogy papers "Über den Bau der Atomkerne I-III (About the Structure of the Nucleus 1-3)" [29,30,31], which decided to adopt the current nucleus theory that proton and neutron constitute the nucleus as the basic assumption of the current nucleus model.

Although it must have been obvious to Schrödinger, Dirac and Heisenberg, that there is a peculiar solution to their equations, which corresponds to the small hydrogen, was in the end rejected [32], because the wave function is infinite at r = 0. The infinity comes from the Coulomb potential shape, which has the infinity at r = 0 as is shown in Fig.8(a).; it was a consequence of the assumption that the nucleus is point-like. In addition, nobody has observed a small hydrogen. At that point, the idea of a small hydrogen died.

However, its idea was revived again ~70 years later [33,34], where Maly and Va'vra argued that the proton has a finite size, being formed from quarks and gluons and that the electron experiences a different non-Coulomb potential at a very small radius. In fact, such non-Coulomb potentials are used in relativistic Hartree–Fock calculations for very heavy atoms, where inner-shell electrons are close to the nucleus [35,36]. Maly and Va'vra simply applied a similar idea to the problem of small hydrogen, i.e., they used the modified realistic non-Coulomb potential that at a very small radius, realistic potential model is that the positive charge is distributed in nucleus uniformly to prevent Infinity at r=0 (in Fig.8(b)), in the Schrödinger and Dirac equations to solve the problem outside the nucleus first, then, they used the above mentioned the non-Coulomb potentials in a separate solution for small radius, and then matched the two solutions at a certain radius. Using this method, they retained solutions for small hydrogen, which were previously rejected. They called these new solutions “deep Dirac levels” (or electron deep orbits (EDOs)) as is shown in Fig.8(d)

Due to the denser electron density between p-p, Coulomb repulsive force can be shielded completely as is shown in Fig8(c) and (d).

This section is based on the works [37]-[49], and the background of the study is described in [39].

Because EDO was proved by experiment of engineering study of hydrogen storage separator study as is shown in sec3.2 and soft x-ray spectra study as is shown in sec 3.3, the Cold fusion mechanism can be based on EDO or small hydrogen.

3.2 Experimental evidence of EDO of hydrogen

3.2.1 High Compressibility of hydrogen negative ion experiment

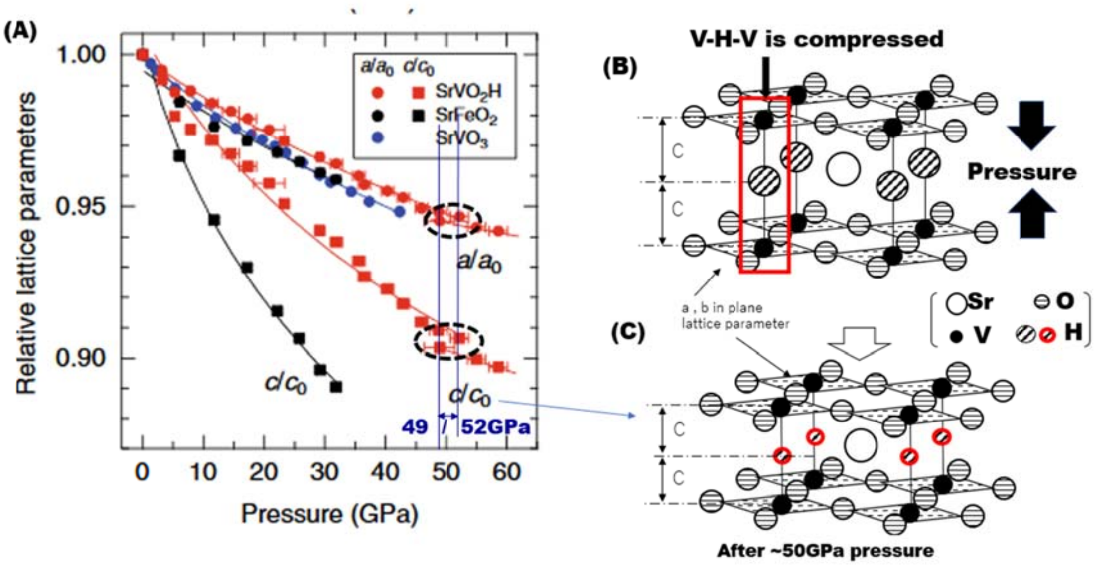

Fig. 9. High-pressure behavior of $SrVO_2H$ and SrFeO [50].

(A) Pressure dependence of lattice parameters for the experimental (red) and the DFT-computed (sky blue) values of $SrVO_2H$ (note that some error bars are smaller than the width of the symbols). The decrease in pressure from 52 GPa to 49 GPa as the cell volume decreases suggests a phase transition to a denser phase. Relative lattice parameters, a/a0 and c/c0, of $SrVO_2H$ (red), $SrFeO_2$(black), and $SrVO_3$(dark blue) as a function of pressure.
(B) Schematics of $SrVO_2H$, and V-H-V bonding, which is compressed by the mechanical pressure.
(C) Schematics of $SrVO_2H$ under the 52 GPa pressure, illustrating the decrease in size of hydrogen negative ion.

Figure 9 is the experimental evidence of smaller hydrogen of the compressed V-H-V bonding [50]. The authors showed via a high-pressure study of anion-ordered strontium vanadium oxyhydride $SrVO_2H$ that H^- is extraordinarily compressible, and that pressure drives a transition from a Mott insulator to a metal at ~ 50 GPa. I think that this experiment is the direct evidence of the existence of EDO as discussed in 3.2.2. I would like to explain D_2 molecule case (D-D bonding) in the actual Cold fusion in place of V-H-V compression as is in Fig. 9(B)-(C).

3.2.2 Transition from D1*s* to D0*s* by the compression of D–D covalent bond

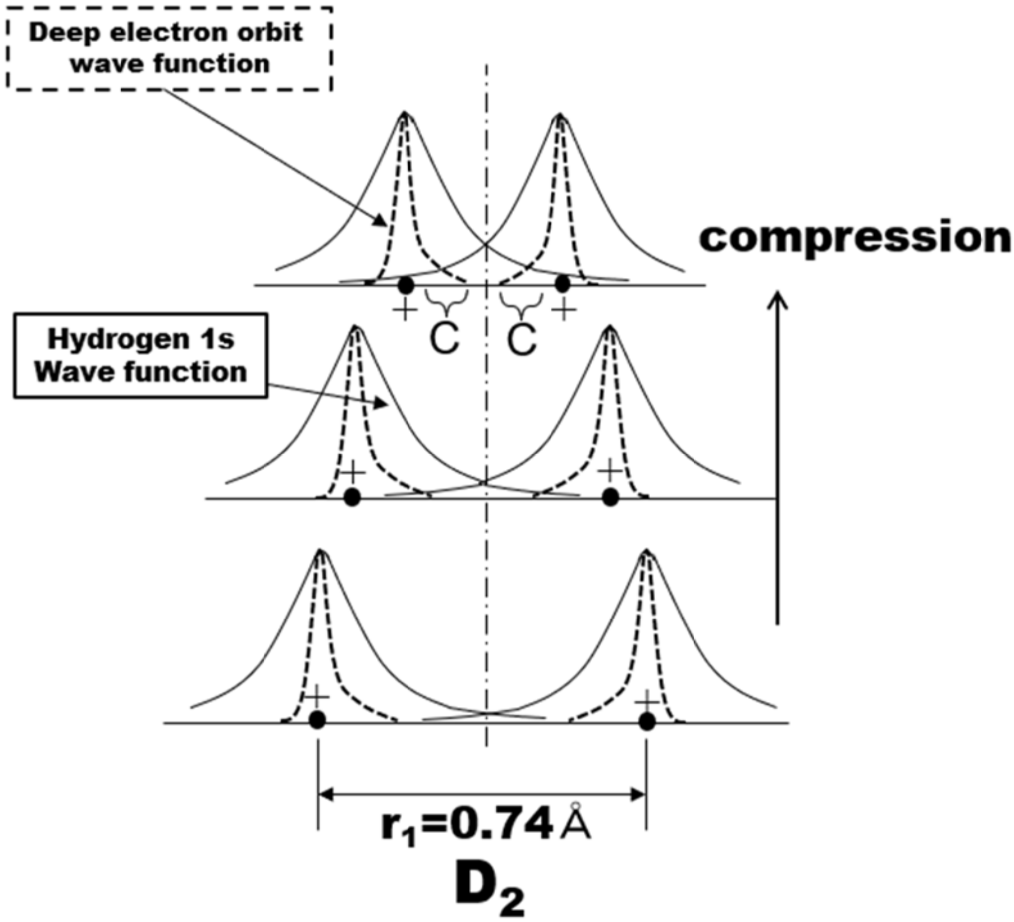

Fig. 10. Mechanism of small atoms (molecules) generation by the compression of D-D covalent bonding.

The mechanism of electron transition to EDO proposed in this work is illustrated in Fig. 10. The size of D_2 at the surface T site is determined by the balance between the compression stress from the lattice metal atoms and the elastic rebound force of covalent bond and due to the nature of the covalent bonding the compression can cause the d-d distance shorter in d-d compression direction that brings two ds to be closer together in a collision direction.

Under compression of D_2 by external pressure, the d-d distance can decrease and the D1*s* wave function tail can extend to overlap with the EDO wave function, which is localized at a distance of a few femtometers from the nucleus. Because the d-d distance is so small, the overlap (C in Fig. 10) of wave functions can be large enough to achieve a high tunneling probability of electrons from D1*s* to the EDO (D0*s*). Radius of EDO is calculated to be few femtometers [42], [43], and is by far smaller than that of D1*s* of 0.53 pm (Bohr radius). A small D_2 molecule can be created due to the simultaneous transition of both D atoms to small D atoms, so D_2 molecule can transform to small D_2 molecule with the covalent electron at EDO as shown in Fig. 8(d).

3.3.1 Soft X-ray spectra measurements verifying the existence of the EDO

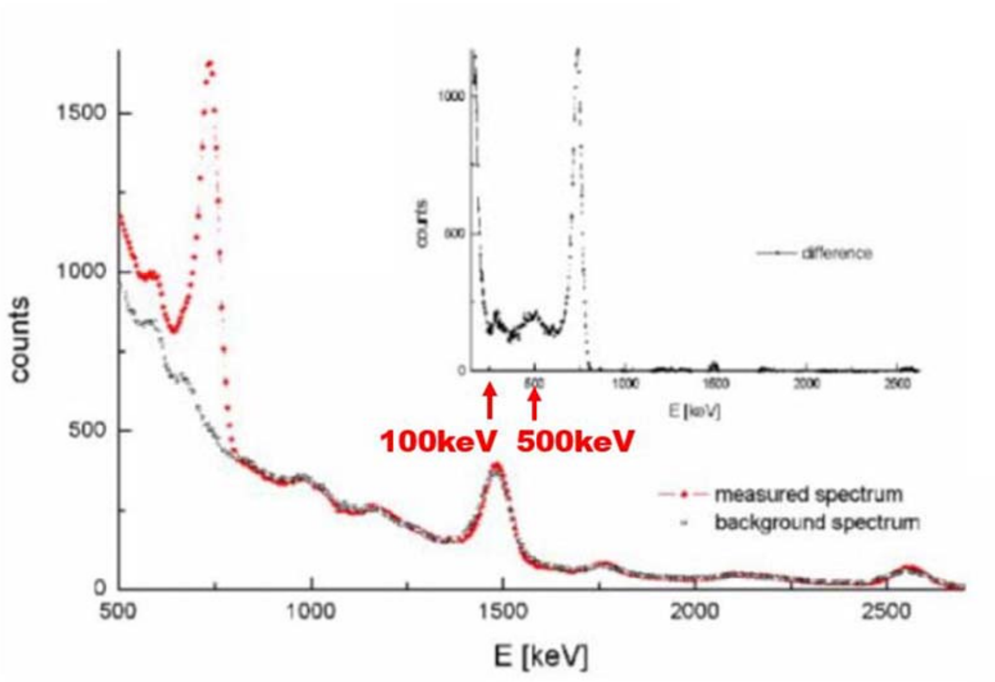

Fig.11. NaIγ-rays spectrum showing a peak superimposed to the background.

The insert, obtained by subtracting the background shows the typical structure of a γ-ray: photoelectric peak, Compton and backscattering peak. In ref [51], Figure.7.

The direct evidence of EDO is to detect the soft-x-ray based on the theoretical calculation as follows. The theoretical calculation, which is now under study by Vavra Jerry and temporal results from the private communication shows that photons of these energies in case of relativistic Schrödinger equation are ~507.27 keV, ~2.486 keV, ~0.497 keV or 0.213 keV, depending on which transition is involved.

In case the Dirac equation, these energies are 509.13 keV, 0.932 keV, 0.311 keV, 0.115 keV or 0.093 keV, again it depends on which transition is involved.

Ref [51] has an overview of our experimental activity during the last twelve years. They have been studying the Ni-H system at temperatures of about 700 K. Their investigations have revealed several interesting effects:

(a) energy production for long time (b) neutron emission (c) γ-ray emission (d) charged particles emission (e) appearance of elements other than Ni on the surfaces of Ni samples.

These experiments were performed in several laboratories and tool configuration is the best as far as I know, so I think that reproducibility is excellent and it is very accurate.

As is shown in Fig.11 the soft x-ray spectra has the broad peak at 500keV and sharp single peak at less than 100keV, and one small peak at around 100-200keV. Note that 500keV Peak is broader than peaks at less than 100keV, probably because of the orbit difference effect of EDO of hydrogen, and theoretical calculation roughly matches the measured x-ray spectra except the border peak at 500keV, which is discussed in sec3.3.3.

3.3.3. Possibility to cause the broader soft-x ray profile by the non-true sphere proton shape based on the proton shape measurement.

I would like to discuss here on the cause of this broad peak at 500eV.

As is explained in Historical background of Neutron is explained in 4.1, Rutherford suggested already in 1920 that electron and proton could be tightly bound. The assumption that the small hydrogen is a neutron was finally rejected because the wave function is infinite at r = 0. Since nobody had observed it, the idea of the small hydrogen died. However, r=0 issue was fixed by the practically modified coulomb potential, and more importantly I show that the Cold Fusion is real and is caused by EDO, based on the matching of soft-Xray to the theoretical calculation and high compressibility of hydrogen.

More precisely I would like to discuss the cause of broader peak at 500eV.

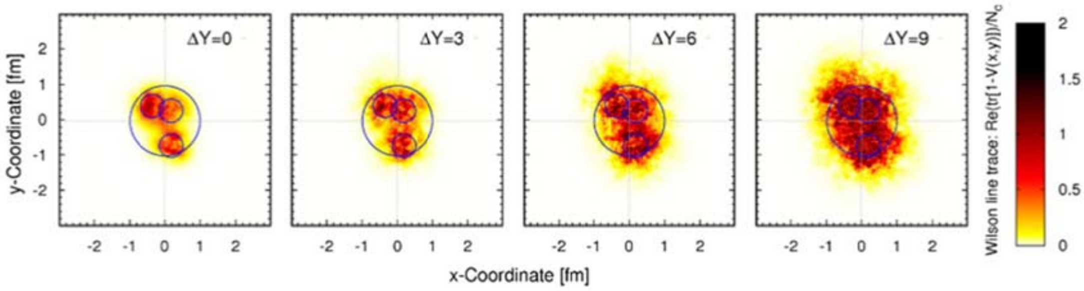

Fig. 12. Transverse profile of a single proton configuration at four different intervals *dY* of the evolution.

The different panels show a contour plot of the real part of the trace of the Wilson line as a function of the transverse coordinates *x* and *y*. The small (large) circles show the position and size of the three constituent quarks (the proton) in ref[52],fig.1.

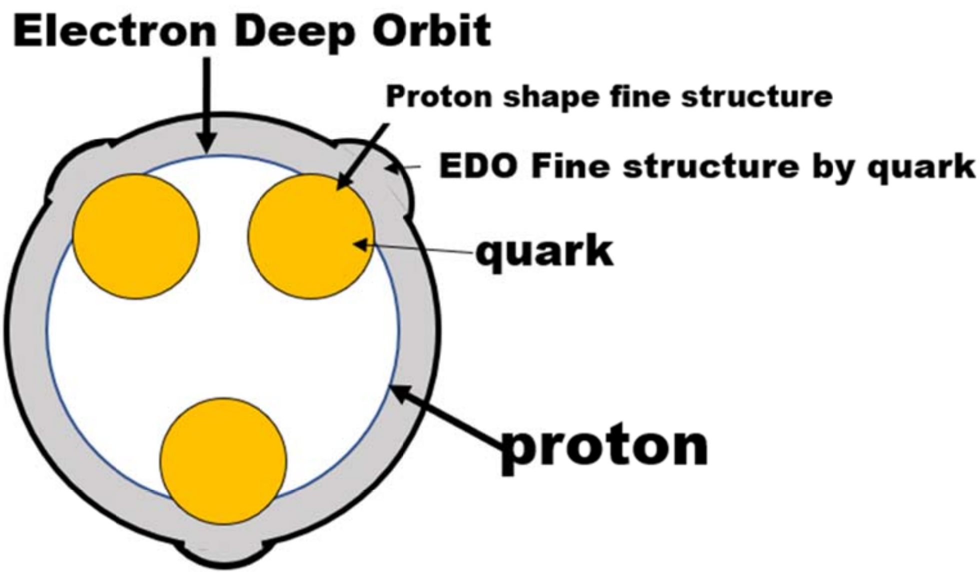

Fig.13 Schematics of proton shape with fine structure by three quarks and Electron Deep Orbit deviation

Figure13 is the proton shape measurement results in ref [52] and this measurement suggested that there is a possibility of proton to have the fine structure by quarks, so it has the great impact on the deepest orbit energy of 500keV as is shown in fig.10.

Because the soft x-ray spectrum study in 3.3.1, Fig.11 shows that 500keV(transition to the deepest orbit) has the broader peak than other orbit, I think that the closest electron deep orbit (r=a few fm) to the nucleus of d must have the very large variation of orbit due to the proton shape deviation from true spheric shape probably caused by three quarks from true sphere, and 500keV broad peak can be qualitatively explained by larger variation of orbit and energy in the deepest orbit caused by the fine structure by three quarks.

Therefore, because peak energy matches with the theoretical value and the deepest orbit have the broader peak than others, these soft x-ray peak result proves existence of Electron Deep Orbit of nucleus. More importantly, assuming that a neutron is a tightly bound proton-electron pair, not a fundamental particle, the beta decay can be explained including larger variation of emitted electron energy variation, which is the important hypothesis of neutrinos as is in ref [3].

4 Other Cold Fusion mechanism

4.1 SO (4) physic [53]

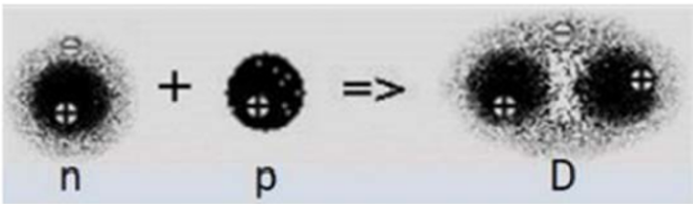

Fig.14 Formation of the deuteron by sharing the neutron shell with a proton

Cold Fusion has the very famous theory of SO (4) in ref [53], which explanation is as follows

SO (4) theory is based on the assumption of neutron structure that neutron is constituted by proton and wrapping electron as is shown in Fig.14 n.

However, the wrapping electron is the electron tightly bound to proton in electron deep orbit theory, which waw firstly proved theoretically by Maly and Va'vra in ref [33],[34]. Thus, Because SO (4) just have the hypo to explain the experimental evidence of neutron beta decay which emit electron from the neutron, the conclusion is the same as electron deep orbit theory. In other words, main theory is electron deep orbit theory and SO (4) is based on EDO theory.

5. Mechanism of known cold fusion reactor and improvement proposition

5.1 Lattice assisted nuclear fusion by laser irradiation

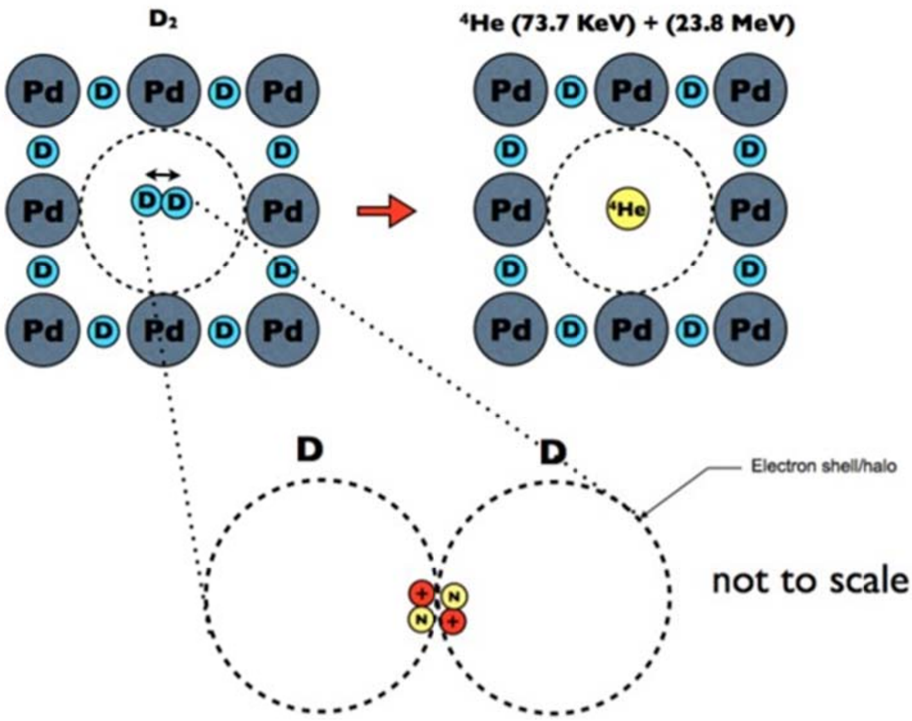

Fig.15 Lattice Assisted Nuclear Reaction with laser stimulation of D-D vibration.[54]

In ref[54], Auther's model is confined D_2 molecules in the metal lattice cause fusion and laser irradiation to enhance the vibration of D-D stretching can enhance the fusion.

The vibrational frequency of the D_2 molecules in vacancy is calculated. The fundamental frequency of the vibrating Deuterium molecule in a cavity is 21.65 THz, which is almost identical with the observed "sweet spot" in the two laser experiments at 20.8THz, indicating that this previously unidentified peak represents the self frequency of the Deuterium molecule in vacancy. The fundamental frequencies in vacancies for HD and H_2 molecules are also calculated. It is predicted that these frequencies in HD or H_2 systems should also activate the reaction and that the fundamental frequencies in cavities should remain unchanged regardless of the hosting lattice.

Hydride bond compression(D_2 molecure compression) is proved by this study.

5.2 Buffer energy nuclear fusion [55]

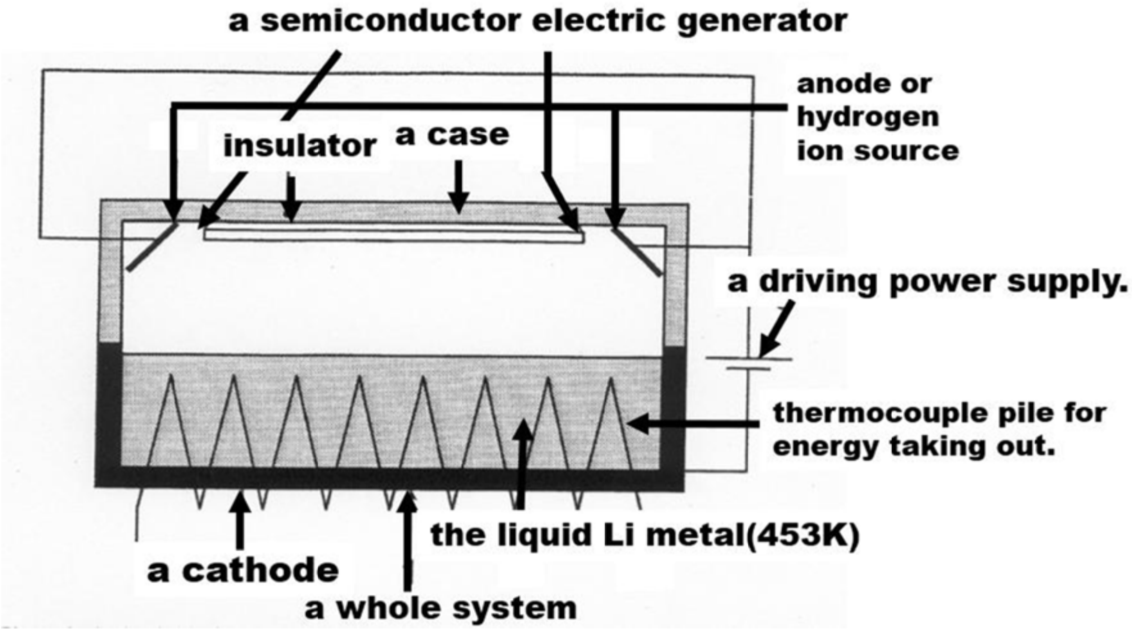

Fig. 16 a showing diagram the principle of operation of a buffer energy nuclear fusion device.

The authors explained that in case that hydrogen ion beam energy lower than 30keV and Li target is melted, abnormal heat generation of 10^{13}times greater than the theoretical nuclear fusion theory.[55]

Hydrogen ions are implanted directly from nonthermal discharge plasma or ion source into a surface of liquid Li metal at a buffer energy of a few tens keV where nuclear stopping occurs. The ions interact with Li atoms or mixed element atoms which are not being internally excited and tend towards the formation of united atoms at the minimum Gibson free energy point. This leads to the enhanced rate of non-thermonuclear fusion of hydrogen ions due to cohesion in the liquid metal.

$Li+1/2H_2$=>LiH⇔Li^{+}+H^{-}

^{7}Li+1H=>$^{8}Be^{*}$=>$2^{4}He$+17.3MeV

^{6}Li+1H=>$^{7}Be^{*}$=>^{3}He+^{4}He+4.0MeV

The authors argued the new scheme of buffer energy nuclear fusion in Liquid Li metal. Semi-classical treatments on the fusion rate have also been presented on the basis of Arrhenius equation. The mechanism of rate enhancement caused by the united atom formation under cohesion in the liquid metal are essential for leading to practical nuclear fusion and further systematic investigations are required.

I think that this is similar with E-CAT nano-particle of Li-H compress fusion, which I think is caused by the bond compression of Li-H.

5.3 E-CAT by Nuclear reaction of Li + H. [56]

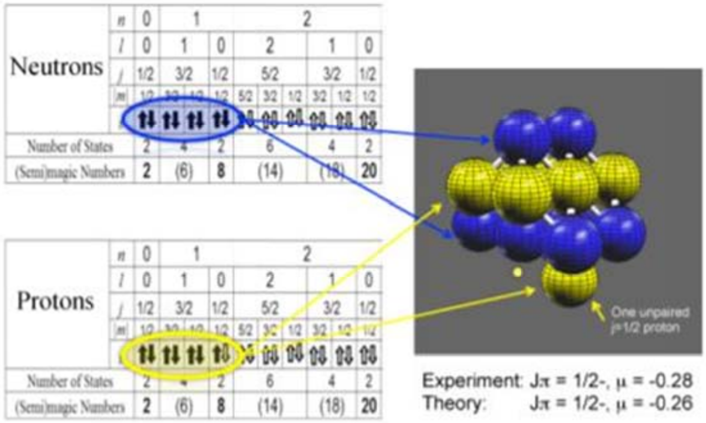

Fig.17 The IPM quantal states of the 8 neutrons and 7 protons of $^{15}{}_{7}N_{8}$ (the filled arrows on the left) and their lattice positions (right).

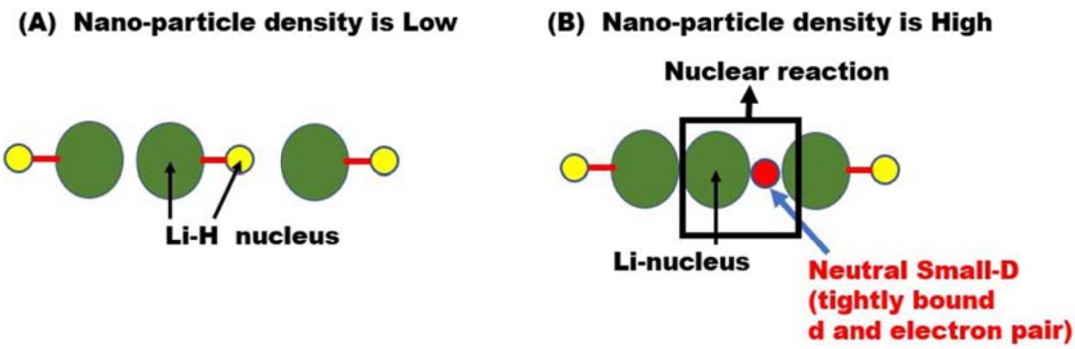

Fig.18 Mechanism of nuclear reaction of E-CAT based on Cold Fusion bond compression theory.

The authors argue in ref [56] that a major source of energy is a reaction between the first excited-state of Li-7 and a proton, followed by the breakdown of Be-8 into two alphas with high kinetic energy, but without gamma radiation. The unusual property of the Li-7 isotope that allows this reaction is similar to the property that underlies the Mossbauer effect

Authors use the lattice version of the independent-particle model (IPM) of nuclear theory to show how the geometrical structure of isotopes indicate nuclear reactions that are not predicted in the conventional version of the IPM.

Authors speculate on similar mechanisms that may be involved in other low-energy nuclear reactions (LENR).

E-CAT uses the nuclear reaction of ^{7}Li + 1H, which is the same nuclear reaction of ^{7}Li+1H=>^{8}Be*=>2^{4}He+17.3MeV as is used by Buffer Energy Nuclear Fusion in ref [55], so the both are based on the same mechanism of hydride bond compression and Buffer Energy Nuclear Fusion has the mechanism of bond compression by ion beam.

Thus, I develop the mechanism theory for this reaction based on H-Li bond compression as is in Fig.15. The Li has hydride bond is Li-H so the compression of Li-H can create the neutron (tightly bound proton and electron pair), so I agree the argument of authors that a major source of energy is a reaction between the first excited-state of Li-7 and a proton, which is actually neutron, which is the small hydrogen (tightly bound proton-electron pair) created by Li-H bond compression which is explained in ref[3].

But note that this reactor has no mechanism of bond compression, so it can be very difficult to trigger cold fusion.

5.3 E-CAT by nano Ni powder and nano [57]

This paper [57] describes the experimental setup, and methodology for assessing the energy in a small volume heat cell, that was loaded with a mixture of nickel powder and lithium aluminum hydride. This paper confirms the results obtained previously by Andrea Rossi and AG Parkhomov - that under

certain conditions the cell makes excess energy; I.E., in the amount of heat released exceeding the input. Initial fuel consisted of a mixture of uniform mixture of Ni powder weighing 0.9g and lithium aluminum hydride (Li [AlH4]) - 0.1g.

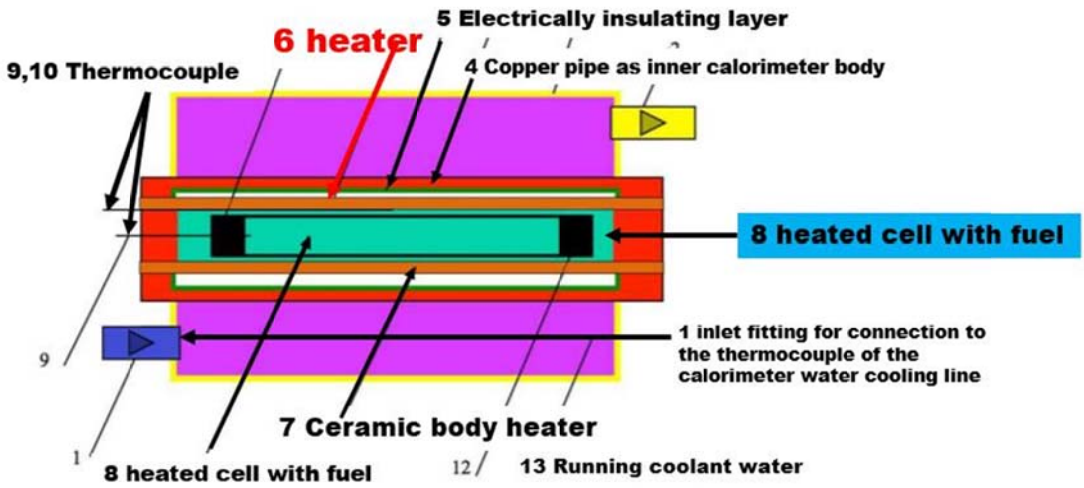

Fig.19 Schematic of the Thermal Generator

This paper [57] describes the experimental setup, and methodology for assessing the energy in a small volume heat cell, that was loaded with a mixture of nickel powder and lithium aluminum hydride. Hydrogen is supplied from Li [AlH4] by the following reaction; At a sufficiently slow rate of heating, as carried out in the experiment, the decomposition of lithium aluminum hydride should proceed according as follows:

with 180°C >T>125°C: 2Li [AlH4] → 2LiH + 2Al + 3H2

with T > 850°C: 2LiH → 2Li + H2

The fuel added to the test cell contained 0.1g of Li [AlH4], and from the complete oxidation of its contained hydrogen, a maximum heating of 2.6 kJ would be realized - much less than the 5 MJ measured in the experiment.

This reactor has the advantage of efficient D supply to Ni nano-particle under the lower temperature from the location near Ni nano-particle. However, this reactor has no mechanism of voltage control of nano Ni particle which need to be improved.

5.5 Lattice Confinement Fusion [58]

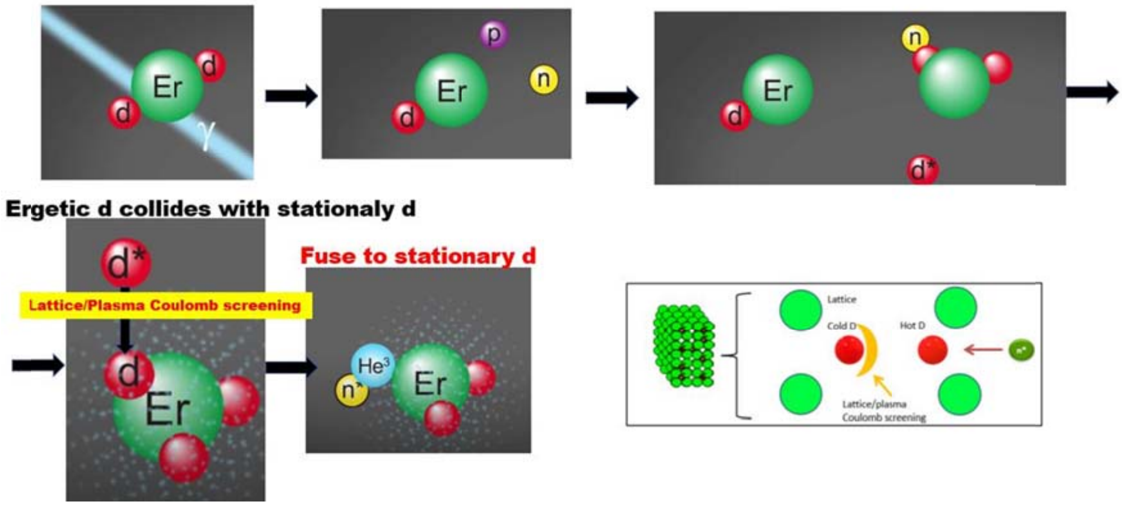

Fig. 20 Mechanism of Lattice confinement Fusion [58],[59]

In ref [58], The authors developed the theory that the metal lattice's negative electrons screened positively charged deuterons to overcome the electrostatic barrier to achieve nuclear fusion initiated by photoneutrons.

However, this is just the hypo and no theoretical study nor experimental data. And probability of collision of hot d to the stationary d is very low due to its size and coulomb repulsive force.

Thus, I developed the Lattice confinement fusion theory based on bond compression.

(A)

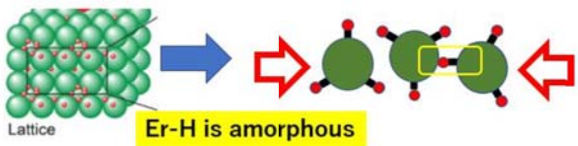

Fig.21 Mechanism of Lattice confinement Fusion based on the hydride bond compression

(A) Mechanism based on hydride bond compression

As is shown in Fig10(A), because Er-D with very high D density is amorphous, it has no clear lattice structure, and Er-d can be compressed efficiently. However, this reactor is no mechanism to compress the bond, and although author think that gamma-ray cause the fusion, I think that the probability of collision of generated d to the d of Er-d seems to be very low due to the coulomb repulsive force as explained in sec 1.1.3, and so I think that their mechanism is incorrect.

I think that Er-D bond compression due to the larger amount of Er-d which can cause by slight fluctuation of the stress of Er-D film as is shown in Fig.19(A). This compression can occur everywhere in the Ni-D film due to the very high concentration of d, and neutral d, which is tightly bound d and electron pair, can fuse to Er and other neutral d with tightly bound electrons. Because the density of Er-D is large, the excess heat is observed only a small percentage of fusion, however, it mainly fuses to Er and transmute Er to the stable element of 168Tr, 169Tr,179Tr, which indicate that the original purpose of this reactor is to prove the cold fusion mechanism not for the actual reactor for commercial/Space use. Thus, I hope NASA will run the experiment to prove the hydride bond compression theory as is in Fig.19(B).

5.6 Cold Fusion Reactor for transmutation

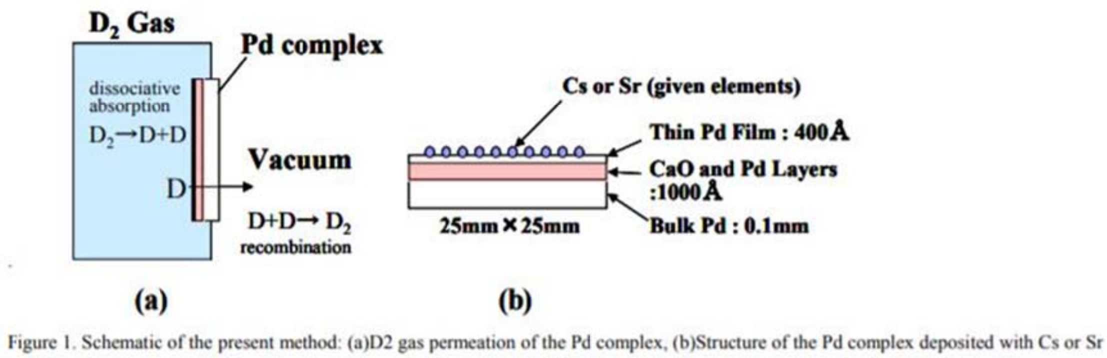

Fig.22 Transmutation in ref [60].

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

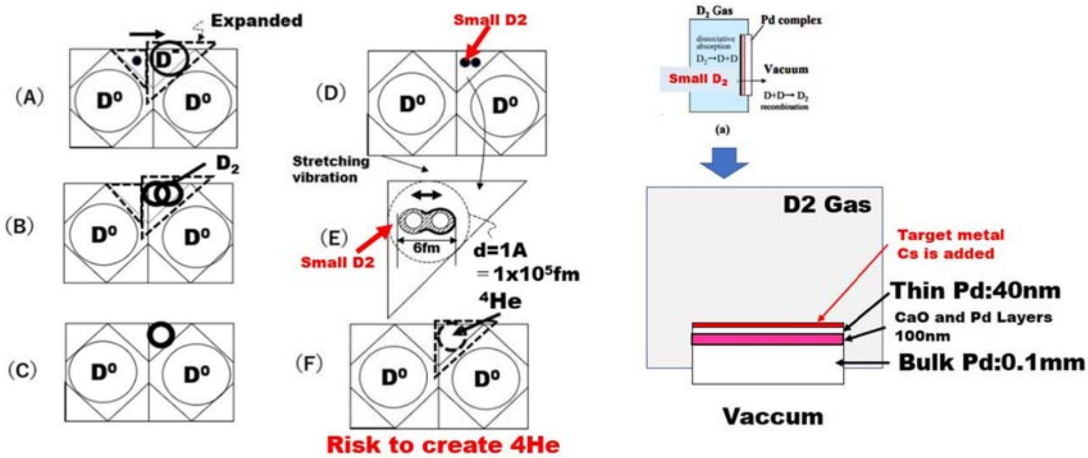

Fig.23 Mechanism of transmutation with D_2 gas and actual reactor configuration based on the report and theory of cold fusion.

Iwamura et.al. studied transmutation by cold fusion with D_2 gas in ref [60].

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 20. However, this figure may incorrect because of the configuration of Pd complex. I think that 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 out diffuse D2 from there to the reaction surface where target metal is. Thus, the correct experimental setting is in Fig.21. based on my Cold Fusion theory, small D2 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 smallD2 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 sec 6.3.

6 Conceptualized Cold Fusion Reactor based on the cold fusion theory

61. compression of metal-hydride film to cause nuclear action

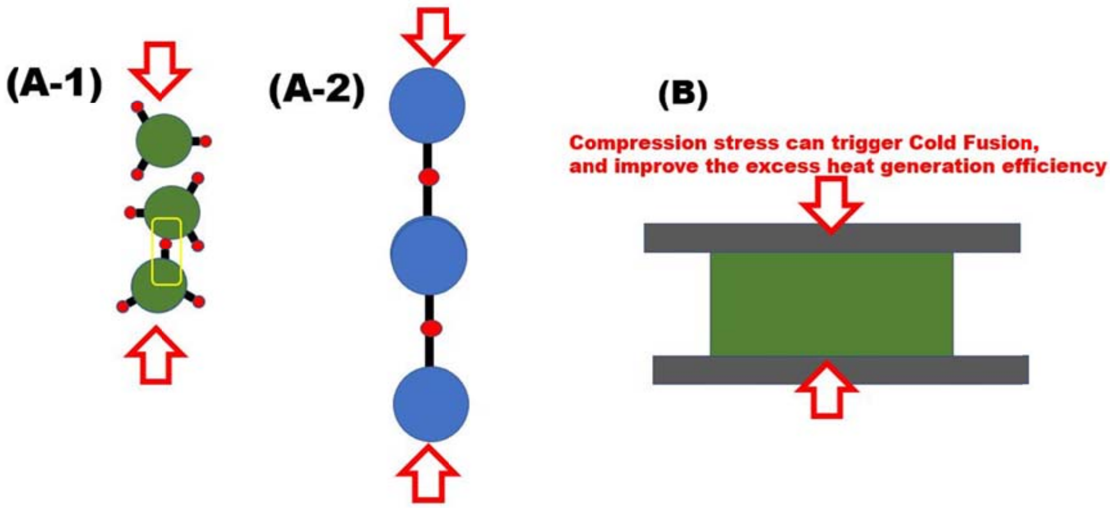

Fig.24 Reactor with mechanical compression of hydride film.

6.2 nano Li-H particle with compression mechanism

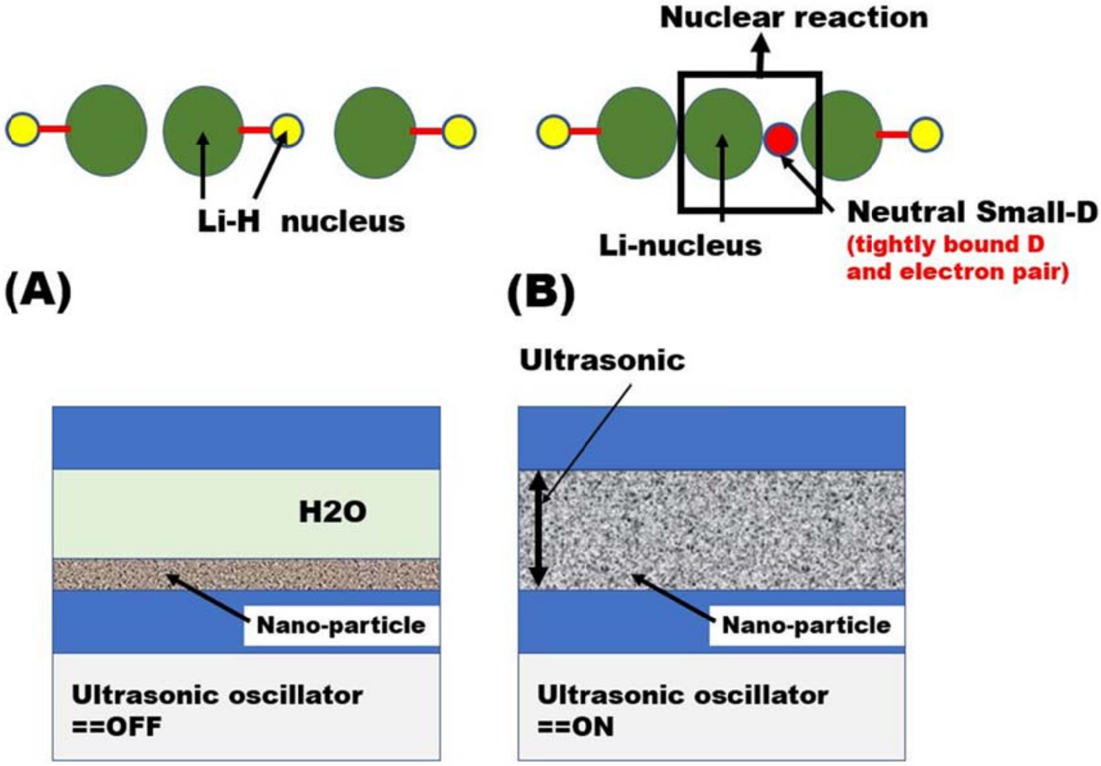

Fig.25 Reactor with compression of nano-particle by vibration

6.3 Nano-metal particle which potential to be controlled

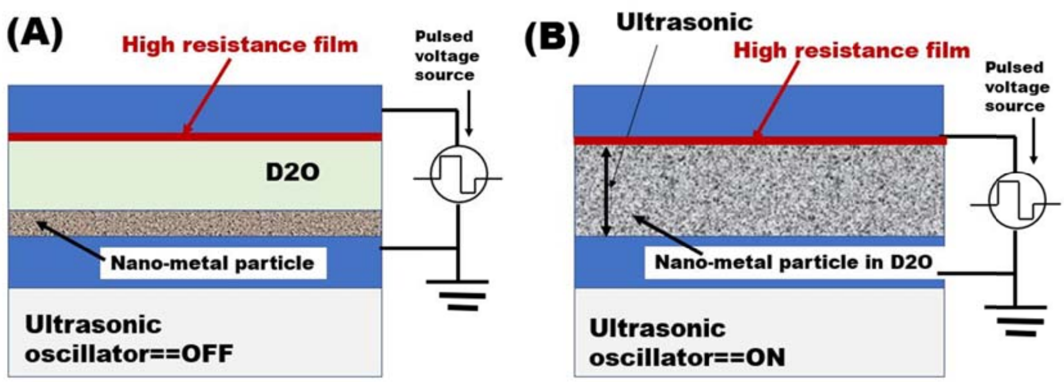

Fig.26 Reactor with nano-metal particle with efficient voltage control by vibration

6.4 transmutation Reactor with H2 gas

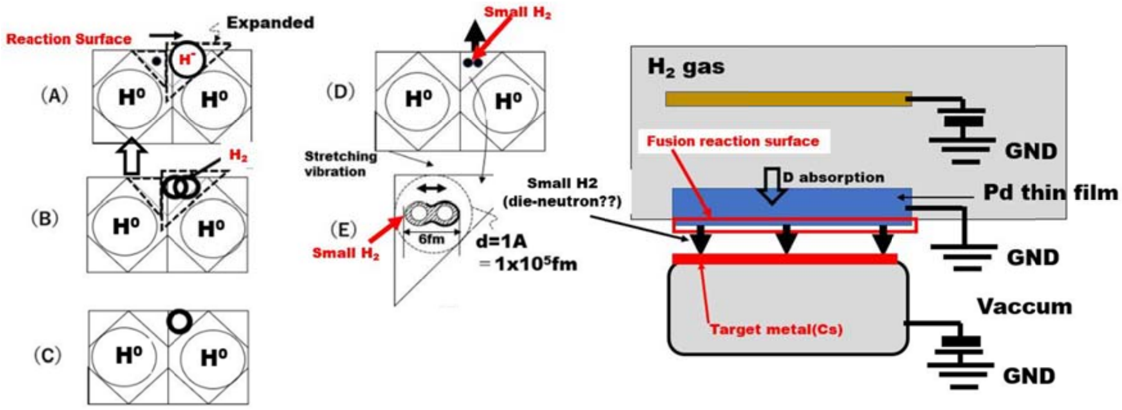

Fig.26 Reactor for transmutation with H_2 gas supply from the backside and potential control of surface and backside potential to create small H2

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,25. This has the advantage of no further 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 3He can be selected by mass spectrometer.

9. Summary

I review the various cold fusion reactor and think on the mechanisms and found that all of the reactor I checked is based on hydride bond compression and creation of small hydrogen, and bond compression of D_2 at the metal surface T site is proved by Lattice assisted nuclear fusion by laser irradiation experiment. Other type of bond compression of Li-H cause the nuclear reaction and Er-D can cause nuclear fusion of d+d=4He and transmutation of Er.

I proposed the experiment to prove the hydride compression theory based on the currently available reactors. I also propose several Conceptualized Cold Fusion Reactors based on the mechanism I explain here, and among these, the cold fusion with potential controlled mechanism of nano-particle is most promising.

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

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