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Cold Fusion Mechanism of Bond Compression

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Abstract:- Cold fusion is caused by the compression against D_2 covalent bond at the expanded tetrahedral site (T site) on the nano-roughness of the metal surface, or by the compression against hydride bond of the element. In case of cold fusion on metal surface, D^- can occupy the surface T site by expanding T site, and adjacent D^+ join to D^- by coulomb attractive force between D^+ and D^-, and D_2 is created at expanded surface T site, thus, D_2 is compressed by the lattice atoms of T site and small D_2 is created by the electron transition from n=1 to n=0, which is theoretically proved by electron deep orbit (small hydrogen) theory.

Above Cold Fusion mechanism is based on the following hypo (1) D^+ and D^- can coexist in the metal, and (2)D^+ join to D^- at the surface T site (3) D_2 exists at the surface T site, (4) compression stress against D_2 in the metal surface T site, and (5) small hydrogen caused by the compression stress against D_2 covalent bond to change hydrogen into small hydrogen.

Lately (1), (3), (5) have been proved by the experiments. (1) has been theoretically studied and experimentally proved by LENR experimental set-up by Lattice Energy Converter by measuring the ion current. (3) has been proved by Lattice assisted nuclear fusion with laser irradiation which laser can trigger Cold Fusion with the frequency of D_2 bond vibration, and neutron scattering experiment showed that D occupies surface T site at the preferentially. (5) has been proved by the experiment showed that compressive stress against vanadium-hydrogen- vanadium(V-H-V) bond can turn hydrogen to be smaller hydrogen, which is the electron orbit transition of hydrogen from n=1 to n=0. Small hydrogen has electron in electron deep orbit of n=0 which orbit is so close to the nucleus and small D_2 has very high electron density between d-d, electron of D-D bond can shield the coulomb repulsive force between d-d perfectly and cause fusion.

Apart from cold fusion in the metal, we have a several other types of cold fusion based on the bond compression. One is the Compression against hydride bonding to trigger nuclear reaction; Typical reactor is E-CAT, and they discussed that Li+H reaction, and I presume that its reaction can be caused by the Li-H bond compression to create the small hydrogen (actually neutron) to trigger nuclear reaction. Because this reactor has no mechanism of bond compression, I propose the conceptualized Reactor with the mechanism of bond compression by the stirring of nano Li-H particle with ultrasonic oscillator to vibrate the nano-particle to collide nano-particles each other, and with the metal plate press the nano-metal particle to compress Li-H bond.

Similar mechanism of bond compression is NASA-Lattice Confinement Fusion. Although authors think differently, I presume that gamma-ray assists the Er-D vibration and some of Er-D bond can be compressed by Er-D vibration induced by gamma-ray by thermal diffuse scattering, however the efficiency must be very low due to the fusion of d to Er.

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.*

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].

Fleishmann and Pons Effect (FPE) is just D absorption under the electrolysis condition in D_2O, and no triggering mechanism of Cold Fusion.

Cold Fusion need to trigger after the D loading in metal, so D absorption and Cold fusion need to be controlled separately.

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, and nano roughness is needed for the metal plate or metal Rod.

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II. OVERVIEW OF THE COLD FUSION MECHANISM

2.1 Mechanism of Cold Fusion in metal

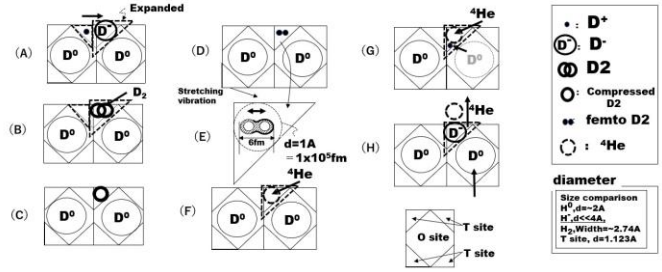

Fig.1. Proposed Cold fusion mechanism in ref [2].

(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) ^4He forms due to cold fusion.
(G) ^4He is ejected from metal by occupying another D^- at surface T site.
(H) D^+ turns into D^- to eject ^4He, and D0 fills the unoccupied O site.

2.2 cause of surface T site occupation by D-

The neutron powder diffraction analysis in [8] shows that D atoms are located at the tetrahedral (T) sites in addition to the octahedral (O) sites of the surface-near location.

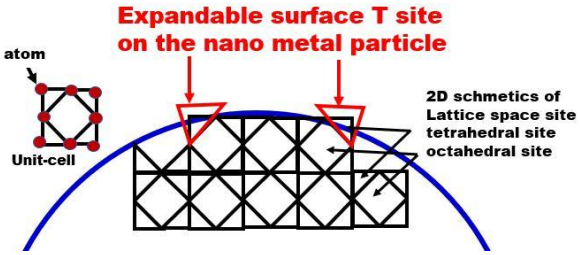

Fig.2. 2-D schematics of nano-particle/roughness size effect of surface T site expansion

Because 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.2. under such condition, the imperfect unit cells are on the surface and the normal unit cell adjacent to the imperfect cell can have expandable T site because no lattice atoms to prevent the expansion of T site atoms shown in Fig.2 In case of nano-metal particles, under the condition of the same weight, total surface area is larger with smaller radius of nano-particle, and the probability to have expandable T site is larger with smaller radius, so the total number of expandable T site is drastically larger with smaller radius of nano-particle.

2.3.1 Evidence that D^+ and D^- coexists in metal by experiment with Lattice Energy Converter

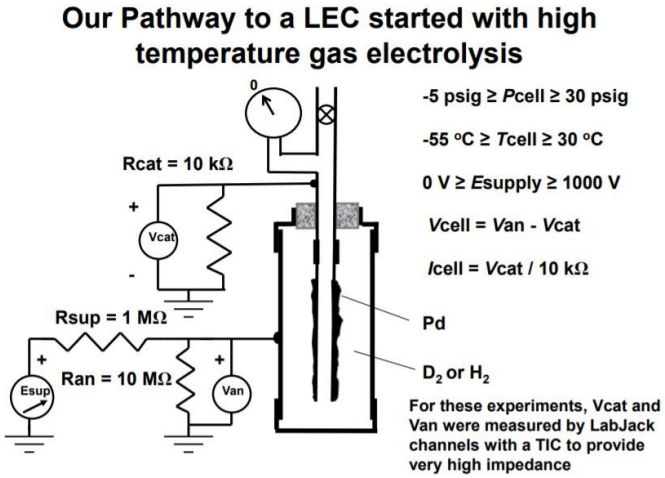

Fig.3. Lattice energy Converter [9]

In ref [9], Authors explained that both open circuit voltage and short-circuit current increases with temperature, and the source, mechanism, and type of the ionization and the ionizing radiation are not known, and sustained LEC operation requires the sustained ionization and authors think that ions of two signs [positive and negative] are spread identically through a gas between two walls,

2.3.2 mechanism of identical ion current

In ref [10], hydrogen state in the metal is reviewed as is shown below.

On the hydrogen state in the metal, several semi-empirical methods have been proposed so far. Among them is a geometric model based on the size of the space in the metal lattice by Westlake. Although this is a very simple method, it is effective as a first approximation. About the electronic state of hydrogen in metal, we had two hypos.
(1) A proton model in which a hydrogen atom completely releases an electron and becomes in the H^+ state.
(2) On the contrary, an anion model in which one extra electron is taken in and the state becomes H^-.

Changes in electrical resistance, magnetic susceptibility, and electron specific heat due to hydrogen absorption have been explained by the model of either (1) or (2) that is more convenient for the situation.

However, recent theoretical calculations of the electronic structure of metal hydrides, founded by Switendick, have shown that both of the above two models capture only one aspect of the facts.

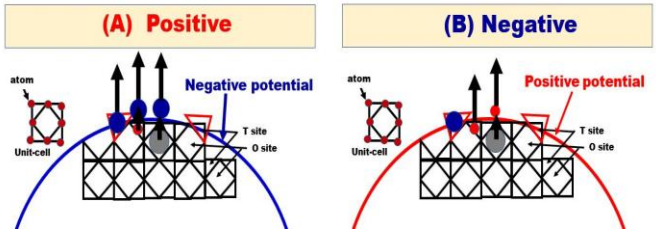

Fig.4. Ion current and applied voltage of electrode in LEC

The experiment by LEC is interpreted to show the mechanism in Fig.4. Based on the latest theoretical study on the hydrogen, the sigh of the hydrogen is determined by the surrounding electronic state of the hydrogen. In case that D occupies at the surface T site, due to the strong electronegativity surrounding lattice atom the electron transfer to D and D turns into D- shown in Fig.1. (A).

And we must think about the electronic state on the surface where the sign of hydrogen can change. In case of the counter-electrode is positive, metal surface potential is negative, so D^x turn into D^- capturing electron from the surface. In other word, only the ion with the opposite charge to the counter electrode.
This shows that ion polarity can be determined by the polarity of counter-electrode, and thus the distribution is identical because the distribution inside metal is D^x (x=-1,0,1) and distinction between D^+, D^0, D^- is meaningless.

2.4 D_2 in the cavity (surface T site) proved by Lattice assisted nuclear fusion with laser irradiation

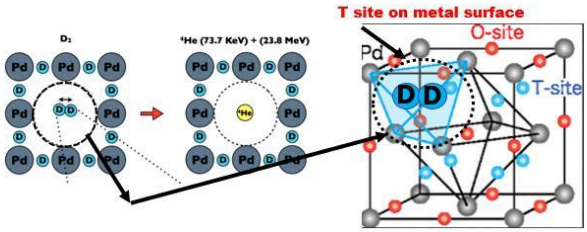

Fig.5. Lattice Assisted Nuclear Reaction with laser stimulation of D-D vibration.[11]

In ref [11], Author'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.

I presume that the existence of D_2 at the surface T site is proved by this experiment as is shown in Fig.4, because the fundamental frequency of the vibrating Deuterium molecule in a cavity is almost identical with sweat spot to trigger cold fusion.

2.4 Compression of D-D bond to create small D_2

The compression of D_2 is explained in Fig. 1(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 fusion. 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 III.

III. ELECTRON DEEP ORBIT (EDO) THEORY

3.1 Background of EDO

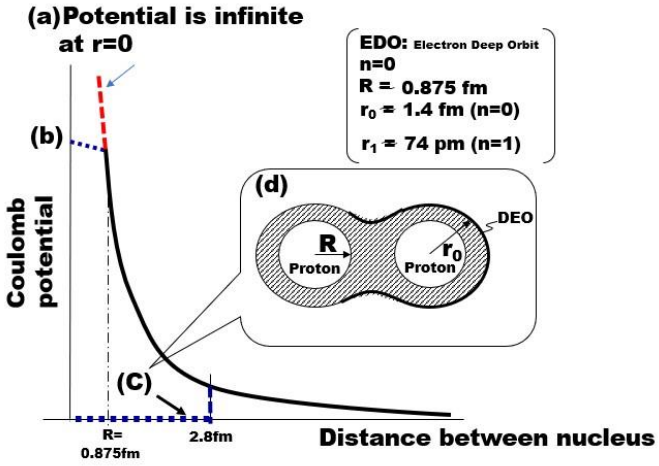

Fig.6. Coulomb potential of small hydrogen with EDO.

A good summary of the history of the neutron is provided in the introductory section of Va'vra's research [12], and this section is based on the works of electron deep orbits in ref [15]-[16], [19]-[31].

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 [13]. Rutherford experimentally confirmed the existence of atomic nuclei in 1911, and he 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, as Rutherford expected.

Heisenberg also supported the hypo that only neutrons and protons are in the nucleus and there are no internal electrons which decided to adopt the current nucleus theory that proton and neutron constitute the nucleus as the basic

assumption of the current nucleus model. However, this nucleus model is incorrect as is ref [3] based on the cold fusion research, and current confusion on the cold fusion mechanism is caused by the incorrect nucleus model and neutron 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 [14], 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.6(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 [15,16], 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 [15,16]. 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.6(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.6(d) Due to the denser electron density between p-p, Coulomb repulsive force can be shielded completely as is shown in Fig6(c) and (d).

3.2 Experimental evidence of EDO of hydrogen;

High Compressibility of hydrogen negative ion experiment

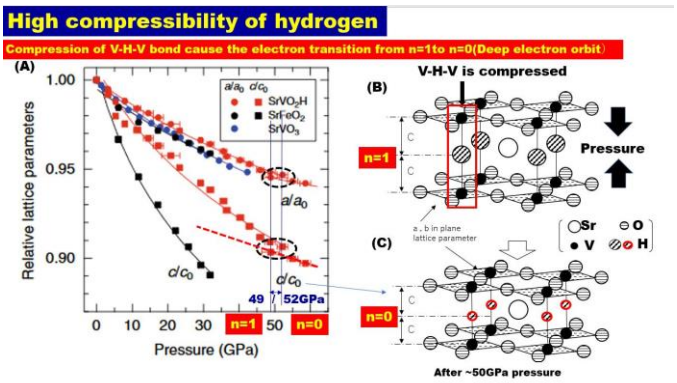

Fig.7. High-pressure behavior of SrVO2H and $SrFeO_2$ [32]

(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 6 is the experimental evidence of smaller hydrogen created by the compressed V-H-V bonding.[32] 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 section III. 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. 7(B)-(C).

3.3 Transition from D1s to D0s by the compression of D–D covalent bond

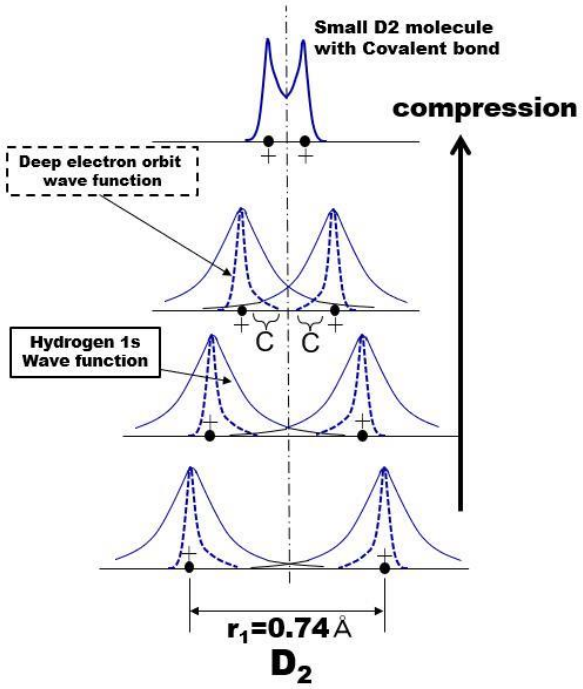

Fig.8. Mechanism of small atoms (molecules) generation by the compression of D-D covalent bonding.

The mechanism of electron transition to EDO proposed in this work is illustrated in Fig. 8. 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 strong compression against D_2 by external mechanical stress of metal T site lattice atoms, the d-d

distance can decrease and the D1s 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. In case that the d-d distance is so small, the overlap (C in Fig. 8) of wave functions can be large enough to achieve a high tunneling probability of electrons from D1s to the EDO (D0s). Radius of EDO is calculated to be few femtometers [24], [25], and is by far smaller than that of D1s 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. 6. (d), and Fig.1. (D), (E).

IV. REACTOR OF COMPRESSION OF HYDROGEN BOND OF NANO-METAL STRUCTURE

4.1 Buffer energy Reactor.

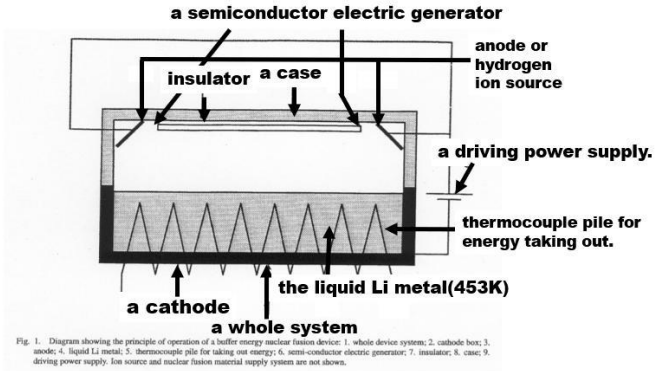

Fig.9. Buffer Energy Nuclear Fusion [33],[34]

In ref [33][34], the effect of thermodynamic force on the nuclear fusion with protons of 10 keV energy was observed in metallic Li liquids exhibiting an enhancement of rate by a factor of about 10^4 in spite of quenching due to nuclear recoil.

Author confined himself to argue mainly the following chemical-and nuclear reaction in Liquid metal as follows.

$Li+1/2H_2 => Li^+ + H^-$
$^7Li+^1H => ^8Be^* => 2^4He+17.3MeV$
$^6Li+1H => ^7Be^* => {}^3He+{}^4He+4.0MeV$

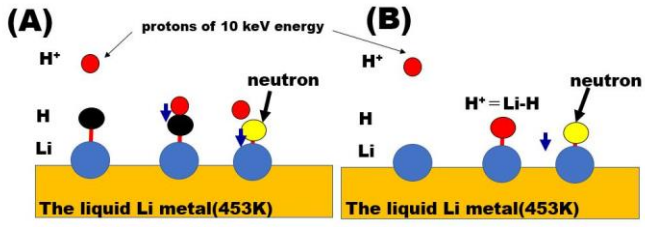

Fig.10. model of bond compression cold fusion for buffer energy nuclear fusion

Based on the bond compression mechanism, proton beam collides to H of Li-H and push H toward Li and small hydrogen is created(A), or proton ion join to Li and move to the Li along with the bond and bond compression of Li-H can create the small hydrogen. Small hydrogen is the tightly bound proton-electron pair so it is neutral and it can fuse with Li.

4.2 E-CAT by Nuclear reaction of Li + H

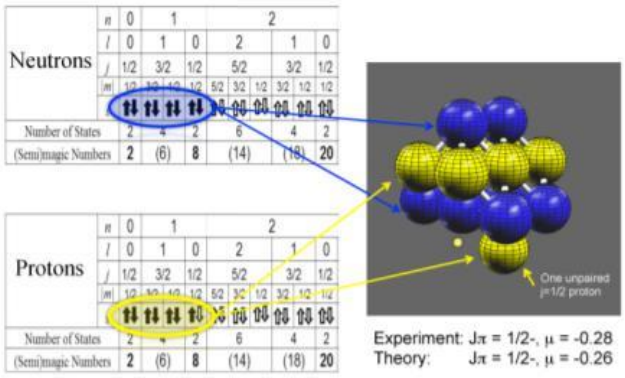

Fig.11. The IPM quantal states of the 8 neutrons and 7 protons of 157N8 (the filled arrows on the left) and their lattice positions (right).[35]

The authors argue in ref [35] 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 as is below reaction.

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). Actually, this effect is cold Fusion of bond compression of Li-H as is shown later.

E-CAT uses the nuclear reaction of $^7Li + {}^1H$, which is the same nuclear reaction of $^7Li+^1H => ^8Be^* => 2^4He+17.3MeV$ as is used by Buffer Energy Nuclear Fusion [34], so the both are based on the same mechanism of hydride bond compression and Buffer Energy Nuclear Fusion [34] has the mechanism of bond compression by ion beam.

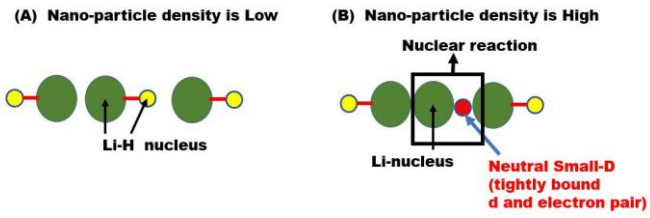

Fig.12. Mechanism of nuclear reaction of E-CAT based on Cold Fusion

Thus, I develop the mechanism for this reaction based on H-Li bond compression as is in Fig.12. The Li has hydride bond is Li-H so the compression against Li-H can create the neutron (tightly bound proton and electron pair), so I agree with 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 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 Conceptualized reactor with compression by string of particles

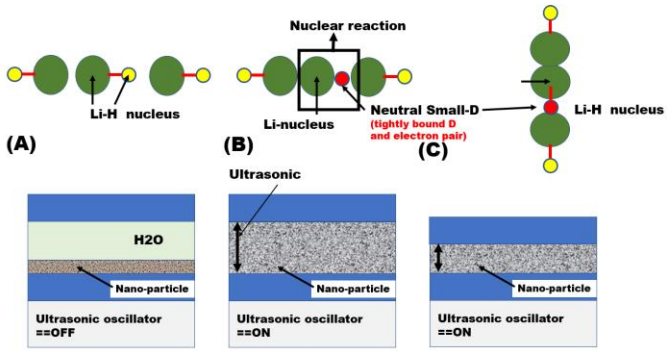

Fig.13. Reactor with compression by 2 parallel plates.

In Fig.13, Li-H bond can be compressed by the mechanical stress with 2 metal plate as is shown in Fig13(C) or ultrasonic oscillation stirring the Li-H in Fig.13(B). Some of Li-H can be compressed and generate excess heat by the nuclear reaction of Li + neutron; neutron (small hydrogen) can be created by the compression of Li-H bond.

5.4 NASA Lattice confined Fusion

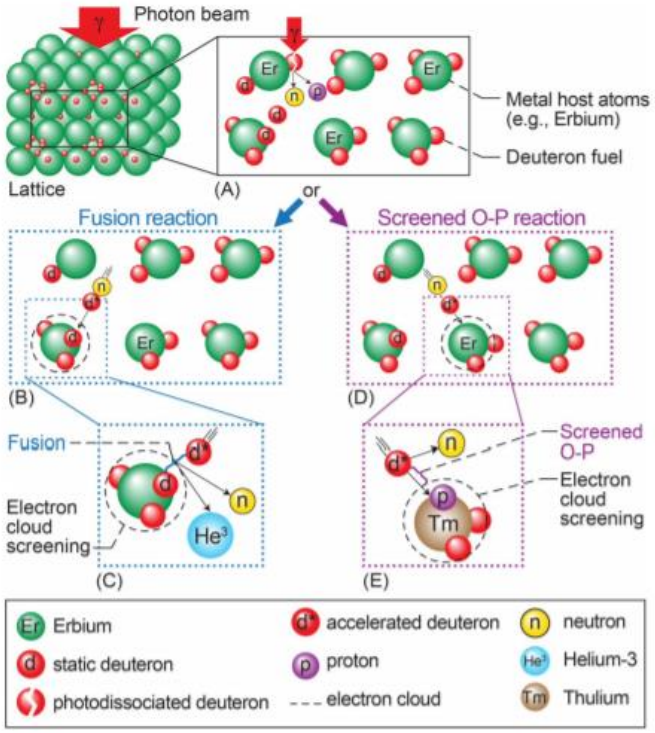

Fig.14. NASA-LATTICE CONFINMENT FUSION [36]

In ref [36], and in Fig.14 authors explain that an electron accelerator produces 2.9-MeV high-energy photons that photo-dissociate deuterons, splitting them into their respective protons and neutrons as shown in part (A) of the figure below. A reaction cascade begins when these energetic protons "p" and neutrons "n" collide with static deuterons "d" in the lattice, which boosts their energy to fusion levels, as represented by "d*" in the figure. The lattice atoms' negative electrons "screen" and reduce the repulsion between the positively charged deuteron ions, further increasing nuclear reaction rates.

However lattice atoms negative electron cannot screen the coulomb repulsive force due to its de-localized electron of the conventional orbit as is discussed in section III.only the electron deep orbit can screen the repulsive Coulomb force. Thus, I develop the mechanism based on bond compression of Er-D.

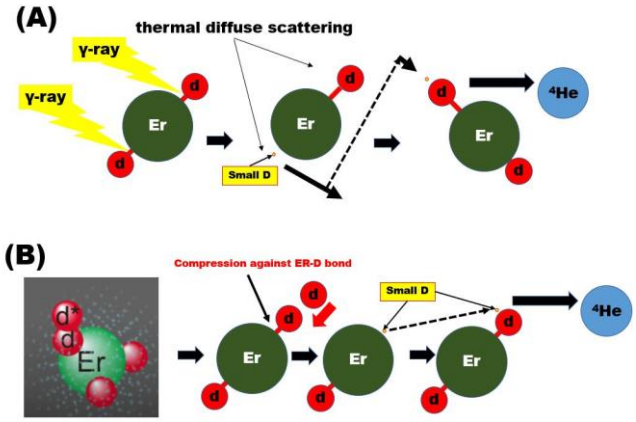

Fig.15. Mechanism of NASA-Lattice Confinement Fusion based on bond compression

In fig15(A), Irradiation of gamma-ray causes the thermal diffuse scattering and it causes the larger Er-D vibration and some of Er-D can compress to create small-D (tightly bound d and electron pair) which is neutral and can fuse to the nucleus of the D and Er to cause fusion.

Another possibility shown in Fig.15(B) that high energy d* created the process in Fig.14(B), and it collides to D of Er-D and it compress the ER-D bond to creates the small D (tightly bound d and electron pair).

However, small-D is created in the proximity to Er so most small-D fuse to Er, and some of small-D can fuse to d of Er-D to generate the excess heat. Thus, efficiency to generate excess heat must be very low.

V. FURTHER STUDY TO PROVE THE COLD FUSION MECHANISM

I would like to request the researchers to run experiments below because the experiment to prove the mechanism of Cold fusion is really needed for the proper design of the reactor, and it is necessary for science society to admit that Cold Fusion is a science not the Pseudoscience.

I have developed the cold fusion mechanism based on several hypotheses and now most hypotheses has been probed but remaining hypotheses is rather important, especially effect

of metal surface potential. Thus, I would like to request the researchers to run experiments to prove the following remaining hypothesis, and publish the papers.

As I explained in ref [3], the nuclear physics society must be responsible for this confusion of cold fusion because cold fusion must be based on the nuclear physics, but current nuclear physics has no theory of small hydrogen; neutron is not a fundamental particle but tightly bound proton-electron pair, which can explain the mechanism of cold fusion clearly. Thus, I would like to ask you to spread the small hydrogen theory.

6.1 New experimental setting is needed

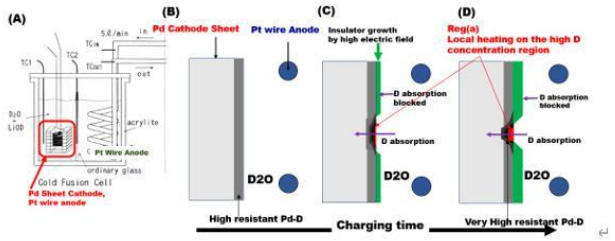

Fig. 16. Fleishmann and Pons Effect experiment

As is explained in ref [2], FPE is just D absorption and no mechanism to trigger cold fusion in their experimental set-up. Because the old experiments used this setting and replication experiment's result was very bad. Thus, the experiment needs to be done with well-designed reactor for the experiment purpose.

6.2. Experiment on the impact of metal surface potential

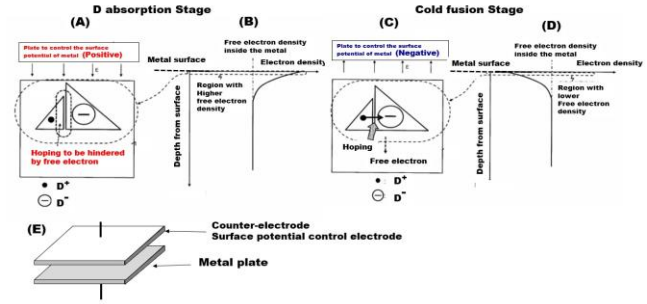

Fig.17. Surface potential for D absorption and Cold Fusion

This is the most important experiment to prove cold Fusion mechanism and to improve the excess heat generation and triggering control self-sustaining temperature of Cold Fusion.

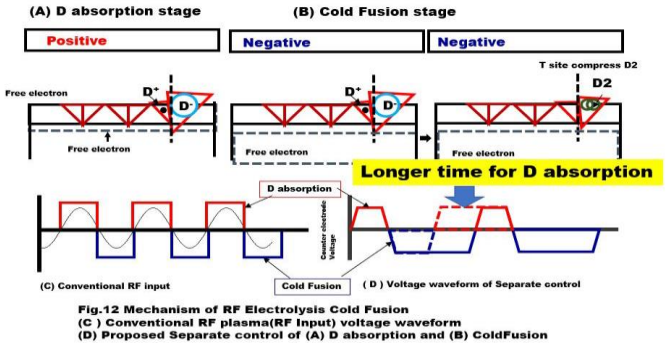

Fig.12 Mechanism of RF Electrolysis Cold Fusion
(C) Conventional RF plasma(RF Input) voltage waveform
(D) Proposed Separate control of (A) D absorption and (B) ColdFusion

Fig.18. Surface potential switching between D absorption and Cold Fusion

Even with FPE experiment, D absorption and Cold Fusion can be switched by the switching the voltage polarity as is shown in Fig.18. Thus, the better excess heat and self-sustaining temperature have been obtained due to the switching of the voltage but not plasma generation in D_2O.

6.3 experiment to investigate the effect on the compressive stress at T site by the surrounding metal atoms.

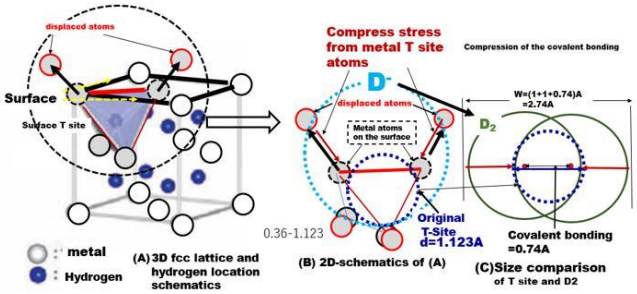

Fig.19. Size comparison among original T site and D^-,D_2

As is shown in Fig.19, the D_2 size is bigger than original T site, so D_2 can be compressed by T site lattice atoms. We have the experiment by Lattice Assisted Nuclear Reaction with laser stimulation of D-D vibration which prove the existence of D_2 in metal, so further study is necessary by this reactor to investigate the effect of compressive stress against D_2 at surface T site.

VI. SUMMARY

I review the various cold fusion reactor and some of the hypothesis for Cold Fusion mechanism have been experimentally proved, however, the remaining hypothesis need to prove by the experiments. Thus, I would like to request the researchers who can run these experiments and published the papers for the cold fusion to be the science.

I found the reactors who uses the bond compression, however the most reactors have no mechanism to compress bond effectively. Thus, I proposed the conceptualized reactor with bond compression.

I request the researchers to run the experiment to prove my hypo of cold fusion mechanism and the most important experiment is the impact of metal surface potential.

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