# Theory of the cold fusion

Noriyuki Kodama

2020/04/14

# Summary

- Cold fusion is the surface of metal reaction
- Hydrogenated Metal surface has the Expanded T site with D-
- Hydrogen has the duality in the Hydrogenated Metal so D+ and D- coexist.
- D- is in the surface T site which expand due to the larger size of D-.
- D+ is adjacent to the T site with D-.
- D+ hops to T site with D- and they turn into D2 gas.
- T site with D2 shrink a bit, so d-d distance is narrower.
- D2 vibrate in the cavity, which is a bit expanded T site.
- Due to the stronger d-d repulsive force, so the d-d coulomb repulsive force shielding still is needed.
- In case that the energy of the D-D stretching vibration is so high that d-d distance is shorter than ~10fm, fusion is possible.
- Experiment of cold fusion need the higher temperature to trigger or laser assisted trigger which are consistent with the necessity of the trigger.
- Electron hinders the hopping due to the coulomb attractive force shielding
- Electron slow down the D-D stretching vibration.
- Thus surface electron must be depleted on the surface-near region of the cold fusion.
- So the surface potential control of the cold fusion tools is required.
- Estimation of the necessary force from Pd atom is $1 \times 10^{-6}$N, but the force estimated by Pd elastic constant is 2 order of magnitude smaller so no force in metal to cause cold fusion from the paper of "Recent ColdFusion" , so we need to think about the D2 coulomb repulsive force shielding or accuracy of the coulomb force at the fm range
- I think that the coulomb force or shielding of d-d coulomb repulsive force need to be re-considered and modified due to the very close location on the order of fm.
- From the proposed theory related with this, Electron Deep Orbits of the Hydrogen Atom is reasonable for me.
- The possibility of fusion can be higher due to the very long duration of D2 vibration.
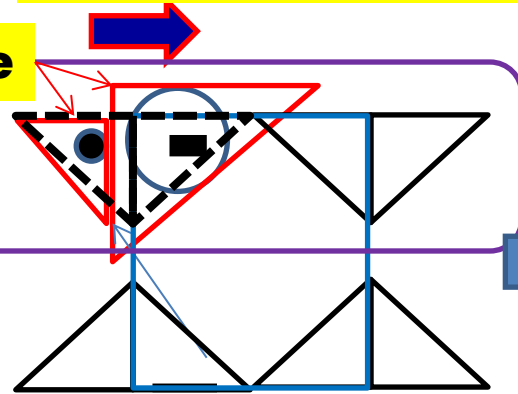
# Summary of the theory of Cold Fusion

H$^-$=2A
H$^0$=1A
H$_2$=0.74A+2=2.74A
T site=1A

**D$^-$**  ⚫**D$^+$**

**Hopping over the potential lowered by coulomb attractive potential**

**T site**

**D2 in the expanded T site**

free electron can shield the Coulomb attractive force.

D2
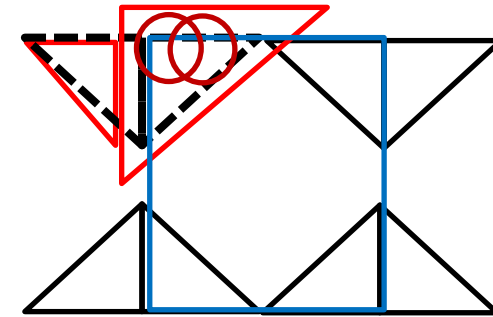
**D- in T site**
**In case that less electron on the near surface region,**
**D+ move to D- and turn into D2**
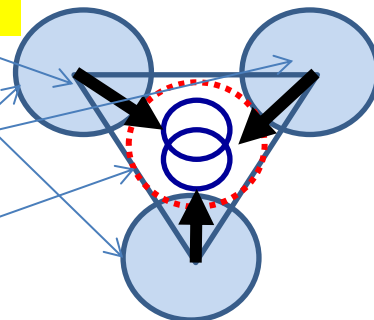**D2 is shrinked to have very narrow d-d distance**
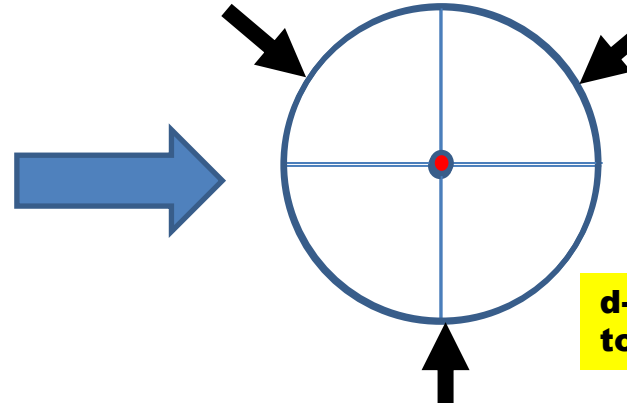
**Stress from Pd**

**Stress from Pd**

**Pd(Down)**

**Pd(Up)**

d-d distance to be very small(~zero)

d-d distance to be very narrow

# Cold Fusion
## Experiments results □in academic societies and my hypo■

- ☐ The surface reaction causes the cold fusion
- ☐ The surface has the so called "Nano-structure"
- ☐ Nano-particle can improve the efficiency of the cold fusion.
- ☐ Nano particle has the D in T site of the surface of the particle.
- ☐ Very high D ratio cause the cold fusion.
- ☐ Very high ratio of H(D) causes the hydrogen brittleness.
- ☐ the hydrogen brittleness is caused by expansion of T site
- ■ T sites of the surface of nano-particle and the flat electrode are easy to expand with D-  and the adjacent site can be smaller and they have D+
- ■ From the above mentioned, I conclude that Cold fusion can be caused by the Expanded T site with D- and adjacent site with D+.

- ☐ Cold fusion is affected by the insulation film on the electrode for the Electrochemical reaction.
- ■ I think this can be caused by the surface potential difference.
- ■ Generally speaking the surface reaction need to control the surface potential.
- ■ I think that Cold fusion can be affected by the surface potential .

# Characteristics of hydrogen storage alloy from the papers

- ☐ The phenomenon of the Hydrogen in a hydrogen storage alloy has been explained by selecting polarities(Anion and Cation) that are easy to explain.

- ☐ Lately it is speculated that the electronic states inside and on the surface of a hydrogen storage alloy have duality of anion and cation.

- ☐ The hydrogen that has entered the space between atoms of the hydrogen storage alloy expands the Pd atoms around it and receives a force proportional to the square of its displacement.

- ☐ The simulation data of the hydrogen movement in the hydrogen storage alloy is available.

- ■ Thus by the simulation we can validate with the theory of cold fusion which is the confined D2 in T site which squeezes the D2 and cause the very narrow d-d distance which can enable the cold fusion.

# Summary:: mechanism of the cold fusion

☐ D-D fusion needs the D2 gas to get the closer distance of d-d.

☐ If you admit that the hydrogen in the hydrogen storage metal has the duality of the polarity(anion and cation), D+ and D- coexists in the metals.

☐ On the condition above, D2 gas can be made by the hopping of D+ to D- in the expanded T site

☐  In that case , <span style="color:red">the coulomb attractive force can assist the hopping of D+ to T site with D-</span>.

☐ <span style="color:red">The free electron can shield the coulomb attractive force</span> so it is needed to control the surface potential of hydrogen storage metal because the cold fusion is the surface reaction.(<span style="color:red">Patent applied</span>)

☐ The stress from 4 Pd atoms can squeeze the D2 gas inside T because the size of the original T site is less than 1.1A, and the size of D2 is 2.74A and the size of D is 1A if the stress is stronger than d-d repulsive Coulomb force.

☐ <span style="color:red">If you accept the above hypothesis , the simulation will show the min d-d distance is narrower than the distance  of the D-D fusion.</span>

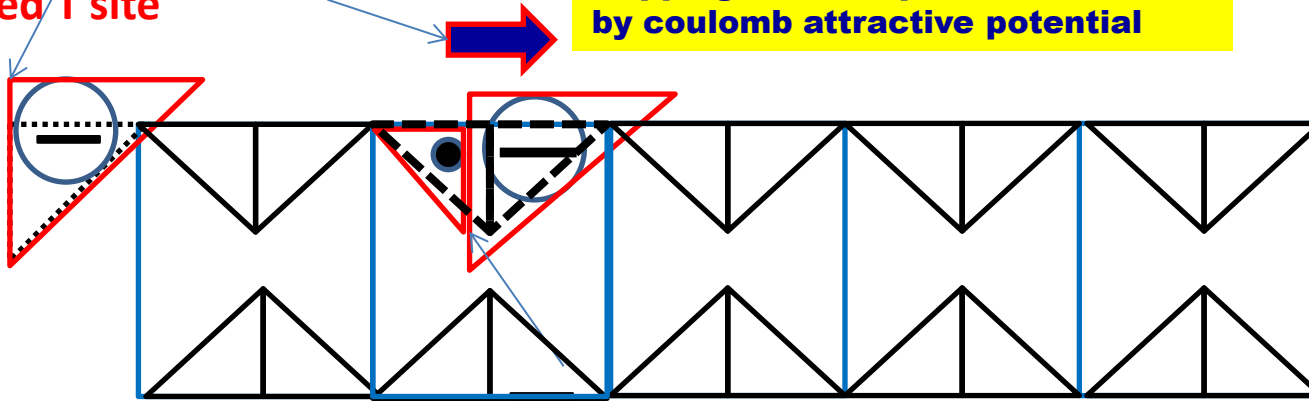# Prior Art showing the mechanism of cold fusion.

$\ominus$ **D-** $\bullet$ **D+**

$H^- = 2A$
$H^0 = 1A$
$H_2 = 0.74A + 2 = 2.74A$

T site expanded on the surface side
Due to no lattice to prevent expansion.

**Expanded T site**

**Hopping over the potential lowered by coulomb attractive potential**

By filling T site with D- cause the expansion of T site to on the upside of the surface due to no Pd atoms to prevent expansion. And the site adjacent to the expanded T site can not expand and D+ smaller D+ can fill such site.
And the prior art has no function to control the surface potentials, the free electrons on the surface near region can shield the coulomb attractive force between D- and D+ and the shielding hinder the creation of D2 and cause the lower possibility of cold fusion.

# Prior Art showing the mechanism of cold fusion.

**The conductor
With positive charge
Or other insulating
Parts inside furnace.**

**Induced electron
shields the attractive coulomb force.**

**Electron on the surface side**

## Electrostatic
## Induction

**Induced charge cancels
the electric field
in the conductor.**
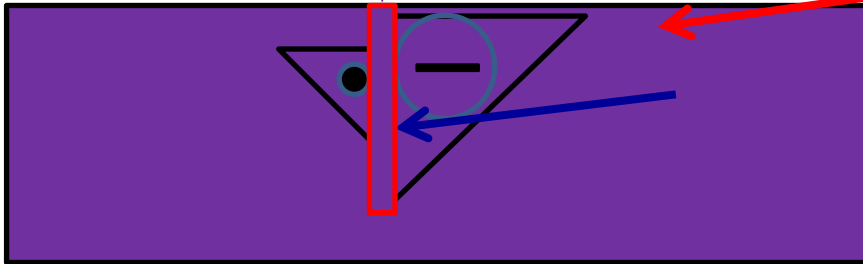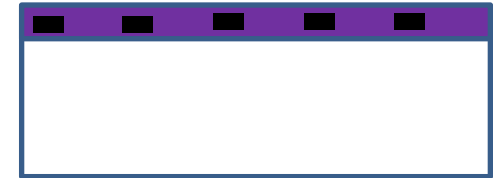
**D⁺ can be move to the T site with D⁻ by hopping over the potential lowered by the attractive coulomb force in case that without the induced electron.
But in case that no surface potential were not controlled, the hopping can be hindered due to the induced electron shields the attractive coulomb force.
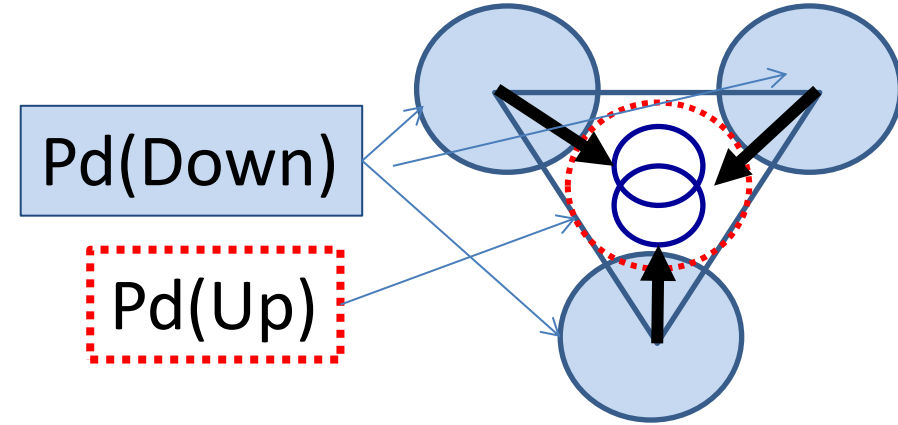The shielding can be done at 1A wide, due to the no electron is in such a narrow space.**

# Schematics of T-site and location of H



T

○ :金属
● :水素

fcc

d
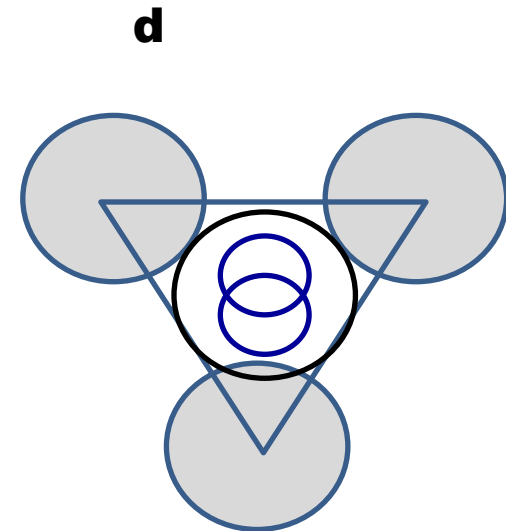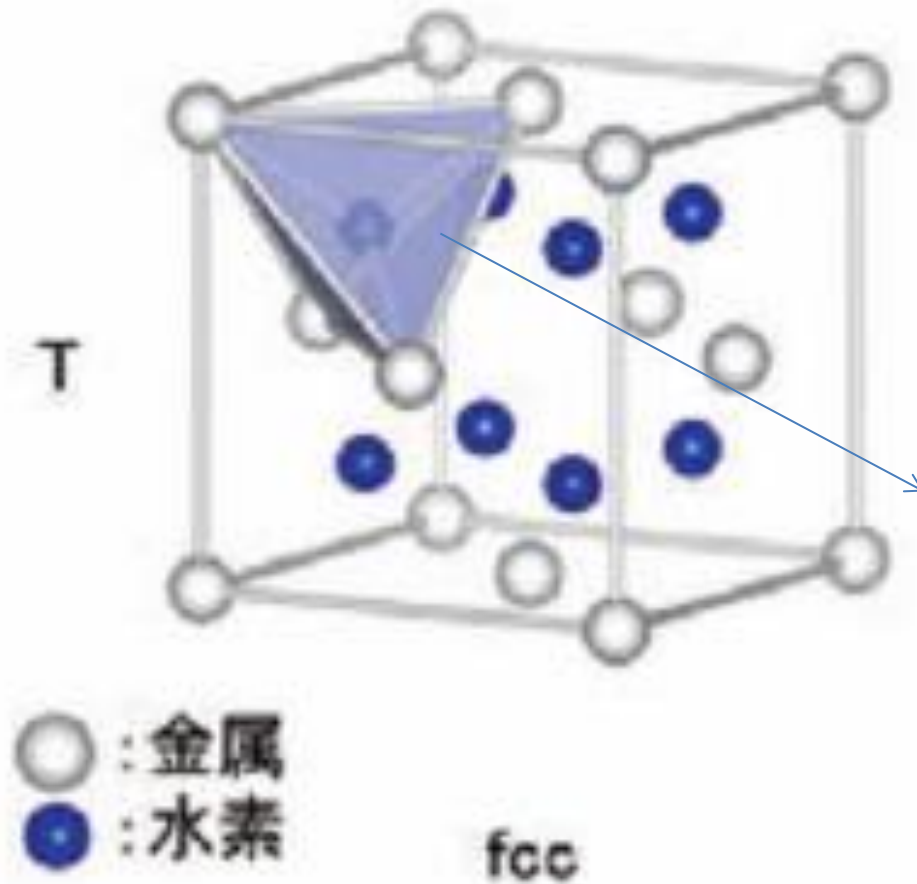
# D2 has the stress from Pd lattice potential

**D2 has the stress from 4 surrounded Pd lattice**
**3 from the in plane bottom Pd and 4th is the**
**upside side Pd of t site**

Pd(Down)

Pd(Up)
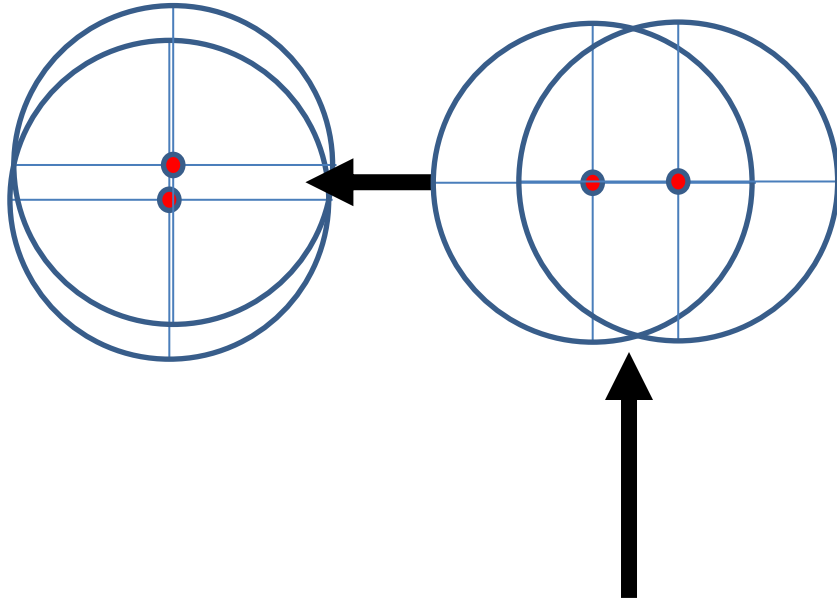
**d-d distance to be very small(~zero)**

**Stress along with 4 different direction can make d-d distance to be very small(~zero) Die to the stronger force.**

# （3）「パラジウムナノ粒子の特異な水素吸蔵」

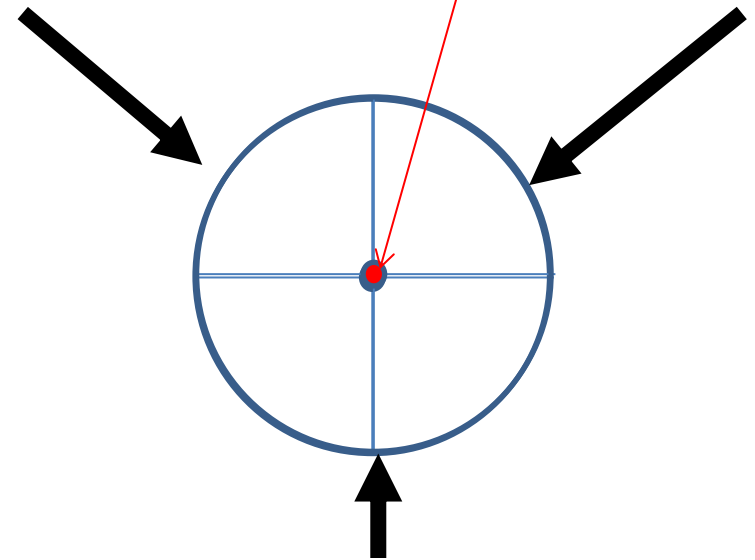## Unique hydrogen storage of palladium nanoparticles

秋葉宙、古府麻衣子、山室修（日本中性子科学会誌「波紋」Vol.27, No.3, pp.95-98, 2017、日本中性子科学会発行）

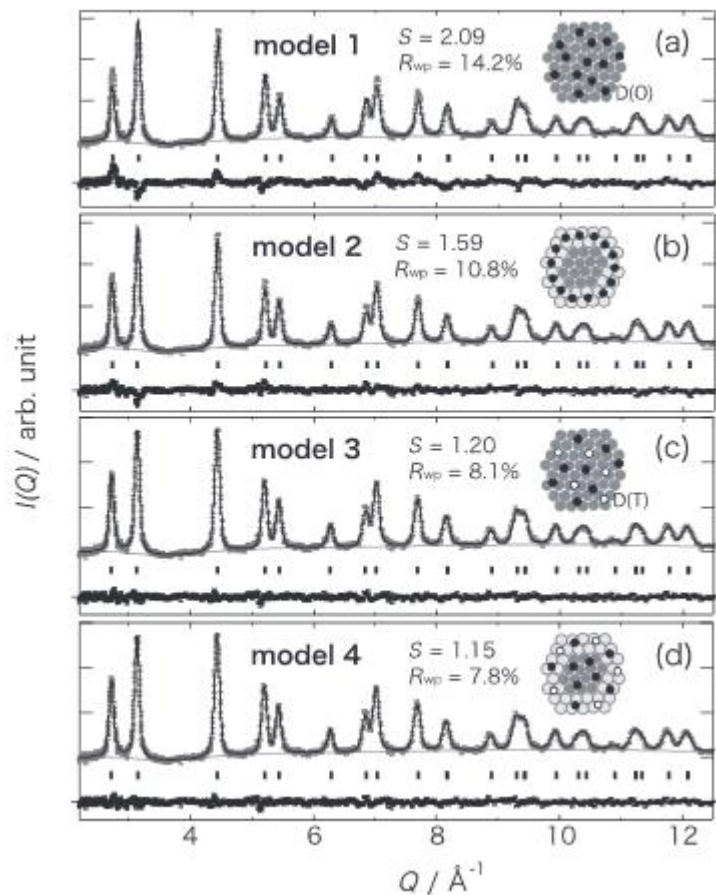https://www.jstage.jst.go.jp/article/hamon/27/3/27_95/_pdf



Fig. 4. Observed (gray crosses) and calculated (solid curves) diffraction patterns of the nanoparticles of PdD0.363 at 300 K. The Rietveld analyses were performed assuming that D atoms are located at (a) the O-sites homogeneously, (b) the O-sites only in the shell part, (c) both the O- and T-sites homogeneously, and (d) the O- and T-sites in the shell part and the O-sites in the core part. The insets show the schematic structural models. The gray circles represent the Pd atoms, and the filled and open circles show the D atoms at the O- and T-sites, respectively.

Models 3 and 4 are models in which D atoms are occupied not only in the O-site but also in the T-site. In model 3, D atoms can be occupied by all T-sites in the nanoparticles, but in model 4, only T-sites in the shell region are allowed. That is, in model 4, D atoms are occupied only in the O-site in the core region and in both the O-site and T-site in the shell region. Although both models reproduce the measured data well, we conclude that model 4 is the most reliable structural model from the temperature dependence of the T-site occupancy rate discussed in the next section.

（5）「金属水素化物の応用物性」山口益弘（水素エネルギー協会（HESS）
# Applied physical properties of metal hydrides
協会誌「水素エネルギーシステム」1986 vol.11, No.2, pp.30-41）

4. 解 説
金属水素化物の応用物性
横浜国立大学工学部 山 口益弘

"Applied Physical Properties of Metal Hydrides"
Ma s u h i r 0 Y AM A G U C H 1
Faculty of Engineering, Yokohama National University,
156 Tokiwadai, Hodogaya-ku, Yokohama 240

On the electronic state of hydrogen in metals.
We had the two different model on the hydrogen state in the hydrogen storage metal.
A proton model in which hydrogen atoms completely release electrons and enter the H+ state,
Conversely, an anion model in which one extra electron is taken into the H- state. Both were traditionally considered, and the changes in electric resistance, magnetic susceptibility, and electron specific heat due to hydrogen absorption have been explained by this model that is more convenient depending on the situation.
  However, according to the results of theoretical calculation of the electronic structure of metal hydrides founded by Switendick in recent years,
It turns out that both of the above two models capture only one side of the fact.

JMJDJOSOTOPES, 63, 489-500(2014)IIト3

金属中の水素のダイナミクス

# Dynamics of hydrogen in metals

パラジウム（英: palladium）は原子番号46の元素。元素記号は **Pd**。白金族元素の1つ。貴金属にも分類される。
常温、常圧で安定な結晶構造は、面心立方構造 (FCC)。



O

T
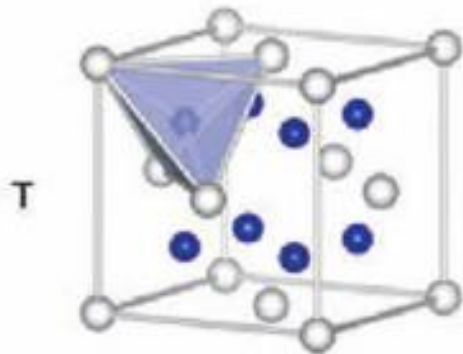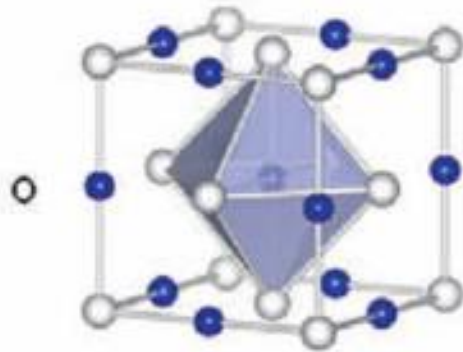
○ :金属
● :水素

fcc

### 2 Potency

When one hydrogen atom enters the metal lattice, the repulsive potential works between the adjacent hydrogen atom and metal atom, and the energy of the whole system becomes high. Displacement of the atom that minimizes the energy of the entire system by the balance between the reduction of the ground energy due to the expansion of the lattice (the displacement of the atom pushed away from the hydrogen atom) and the increase in the lattice strain energy that is approximately proportional to the square of the displacement of the atom. Is decided. As a result, the solid solution of hydrogen causes the metal atoms around the hydrogen atoms to expand. The size of the expanding volume depends on the type of metal and interstitial position, but is almost constant for transition metals and falls within the range of $0.0026 \pm 0.0005$nm.

➔This simulation can be applicable to verify the min d-d distance with including d-d repulsive potential.

# 金属における吸着水素と吸蔵水素の電子状態と反応性
## Electronic states and reactivity of adsorbed and stored hydrogen in metals

ただし金属内には自由電子がありその遮蔽能力が高いので、
（文献では単純なジェリウムモデル（自由電子の海のモデル）でも
数Aで核子間のクーロン力は遮蔽されるというシミュレーションがある。
金属における吸着水素と吸蔵水素の電子状態と反応性

http://www.qcri.or.jp/pdfs/Shokubai.33.270.PDF

Hydrogen in metal
Approximating a metal to a sea of free electrons is the simplest approximation.
Norskov approximates a metal with a nucleus-free, uniformly positively charged potential and with enough electrons to neutralize it (jellium model), put H2 molecules there, and change the H-H distance. We calculated what happens to the energy when stretched by the density functional theory.
Even in such a simple model, when H is put in a metal, the surrounding charge distribution is charged concentrically with H as a concentric circle, and positively and negatively is positively and negatively charged. It can be seen that is blocked by only 0.6A.

This suggested that Hydrogen on the surface of the metal can have the duality of H+ and H-  and 0.6A can shield the coulomb attractive force between D- and D+.

【課題】常温核融合を安定的かつ再現性良く実現できる常温核融合装置、発熱方法および
発熱体を提供する。
【解決手段】平板形状の発熱体(101)と発熱体の平板面に対向して設けられ発熱体の
表面電位を制御する対向電極(102)とからなり、対向電極により発熱体の表面電位を
制御することで発熱体の表面で常温核融合を発生させる。重水素ガスを吸蔵した水素吸蔵
金属(101)の表面(101a)の電位を対向電極(102)により制御することで常
温核融合を発生させる。水素吸蔵金属(101)の表面電位を表面(101a)の自由電
子の濃度が低下する方向に低下させるように、対向電極(102)に電圧を印加すること
で常温核融合を発生させる。
【選択図】図7

PROBLEM TO BE SOLVED: To provide a cold fusion device, a heat generation method and a cold fusion device capable of realizing cold fusion stably and reproducibly.

Provide a heating element.

SOLUTION: The heating element (101) having a flat plate shape is provided so as to face the flat plate surface of the heating element.

The counter electrode (102) for controlling the surface potential controls the surface potential of the heating element by the counter electrode.

By controlling it, cold fusion occurs on the surface of the heating element. Hydrogen storage that stores deuterium gas

By controlling the potential of the surface (101a) of the metal (101) with the counter electrode (102),

Generate a nuclear fusion. The surface potential of the hydrogen storage metal (101) is set to the free electric potential of the surface (101a).

Applying a voltage to the counter electrode (102) so that the concentration of the child decreases.

To generate cold fusion.

# Example-1
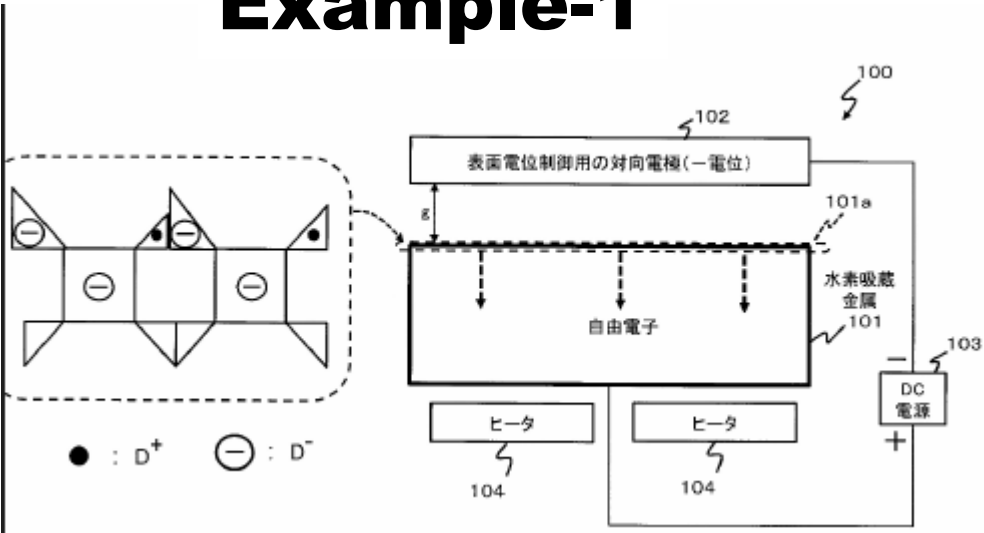
# Cold fusion tools with field plate
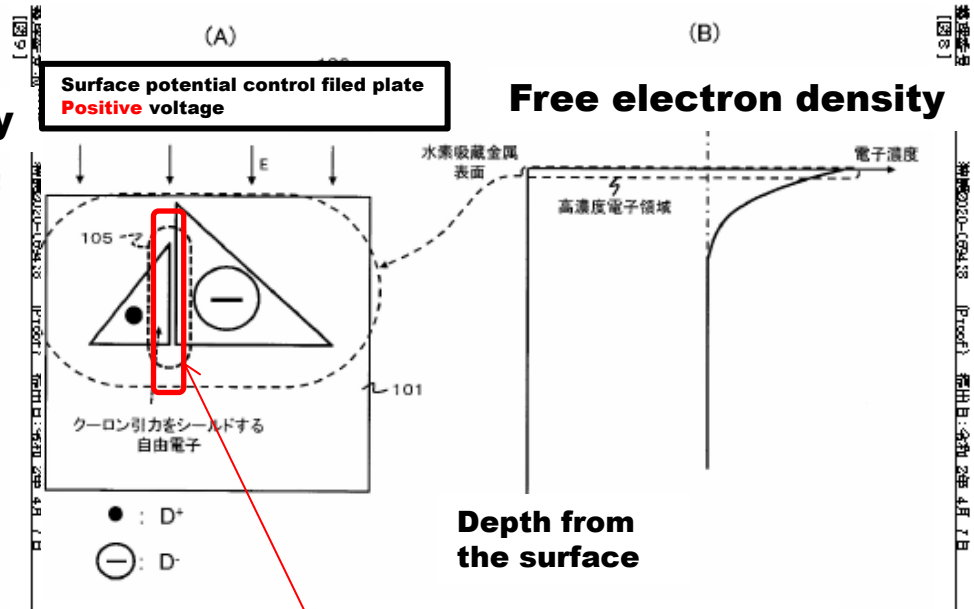# to adjust the surface potential of the hydrogen storage metal



(A)

Surface potential control filed plate
**Negative** voltage

Free electron density

水素吸蔵金属表面

電子濃度

高濃度正電荷領域101a

ホッピング

Hopping

自由電子

● : D⁺

⊖ : D⁻

Depth from
the surface

(A)

Surface potential control filed plate
**Positive** voltage

Free electron density

水素吸蔵金属表面

電子濃度

高濃度電子領域

クーロン引力をシールドする
自由電子
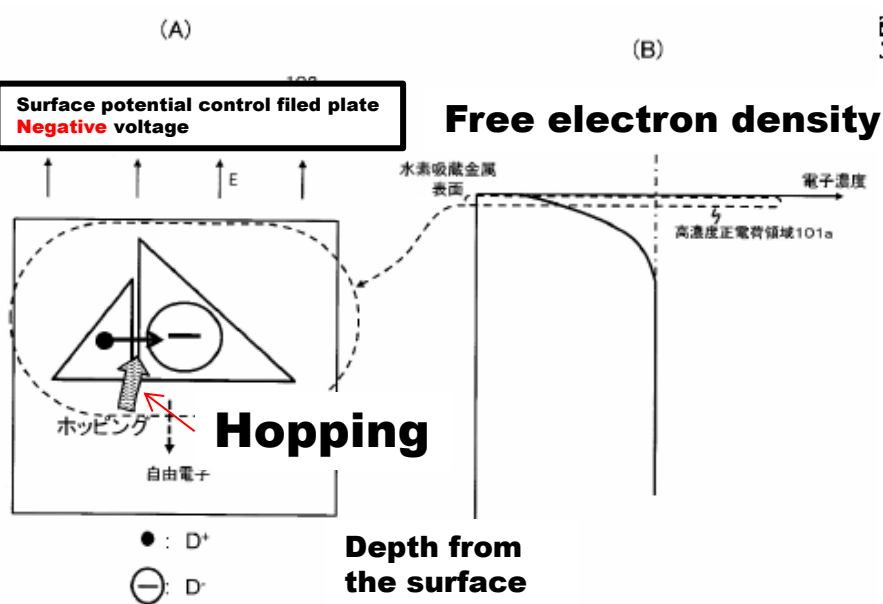
**Free electron shield
the Coulomb attractive force**

● : D⁺

⊖ : D⁻

Depth from
the surface

# Nano structure on the metal plate

Nano particle must have the electrical connection to the ground and the surface of the Nano structure potential must be adjusted on the positive side to deplete the free electron from the surface near region by the field plate.

# https://www.lenr-forum.com/forum/latest-posts/
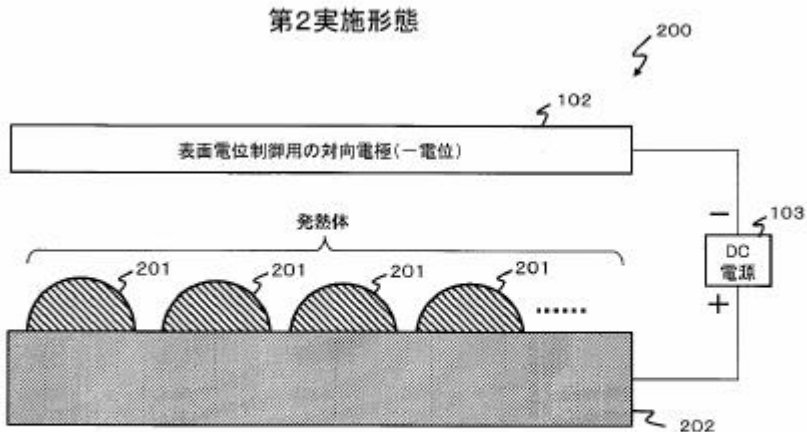


**nkodama** — Member — Online

23 minutes ago

Hi

I would like to share my cold fusion theory and patent, and I am looking for the venture company of cold fusion to verify the theory and the patent.
I am the person do not belong to the company and I applied for the patent in Japan.
I will share the patent with the venture company if they did experiment on the patents.

Here is my cold fusion theory(Confined D2 gas in the T site of the metal).
This is the original theory of cold fusion but lately few researcher has focus on this.
The Cold fusion can be done with the D cluster in metal, and I specify them.
D cluster is D2 gass and location is the surface T site.
The T site with D- is expanded and the adjacent site can be smaller with D+,
Note that the surface T site can be expanded easily.
so D+ hopps to T site with D- and they turned into D2 cluster.
So the original T site W/O D is smaller and the Pd atoms push the D2 gas(2.74A) to confine the very narrow space(~1A).
So the we need the simulation to know the min d-d distance.
And under this theory the control of the surface potential of the metal is important(this is my patent).
So if we do theexperiment of the surface potential and cold fusion performance I can verify my theory and verify the petent.
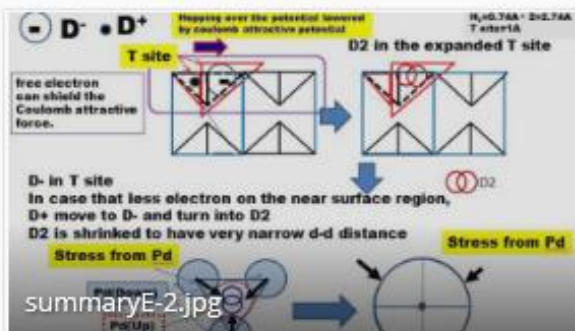If you are venture company or the researcher and will work on them to verify the patents and theory,
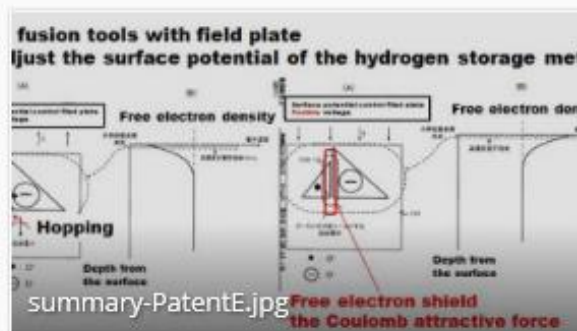I will share the patent with you.please contact with me if you will work on this
noriyuki.kodama.0820@gmail.com

**Revised on 2020/04/30**

Images

summaryE-2.jpg — 69.31 kB — 642×485 — 1

summary-PatentE.jpg — 46.28 kB — 720×339 — 1

# Physical Model for Lattice Assisted Nuclear Reactions
## Jozsef Garai

**Abstract**

Atomic scale description of the electrochemically induced cold fusion is presented. The model consistent with the conditions required for successive experiments and offers physical explanation for the occurrence of nuclear fusion at low energies. Based on this atomic scale description, <span style="color:red">the vibrational frequency of the D2 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 20.8 THz,</span> indicating that this previously unidentified peak represents the self frequency of the Deuterium molecule in vacancy. The fundamental frequencies in vacancies for HD and H2 molecules are also calculated. It is predicted that these frequencies in HD or H2 systems should also activate the

reaction and that the fundamental frequencies in cavities should remain unchanged regardless of the hosting lattice.

**D2 in metal**

The known and detected nuclear fusion processes of deuteriums in plasma and hot fusion reactors are [18]

1./ D + D → T(1.01 MeV) + p (3.02 MeV) (50%),
2./ D + D → 3He (0.82 MeV) + n (2.45 MeV) (50%), and
3./ D + D → 4He (73.7 keV) + (23.8 MeV) (10-7).

However, X-ray emission from well focused point source has been detected [19].
The spectra of the emitted x-ray is consistent with the K-alpha radiations of the elements present on the surface of the cathode along with some Bremsstrahlung [20-22]. The radiation flux correlates with the produced heat [23, 24].

E4./ presence of D2 molecules in the palladium deuteride
[The interaction of the Deuterium atoms require the presence of D2 molecules, which can be formed at higher loading than 0.85 in the presence of vacancies. Many experiments, with very high loading, produced no excess heat, indicating that the bulk PdD is not active. However, excess power had been reported immediately after Pd Co-deposition [19, 28], allowing D2 molecules to be loaded.]

E5./ presence of mono-vacancies
[The formation of D2 requires mono-vacancies because the electron density in PdD is too high for molecular D2 formation. The D2 molecule in the vacancy are stable only if all of the O-sites are occupied, which requires 0.85 or higher loading [29].]

E10./ The heat production is localized, like hot spots, which are associated with mini explosion [36].

**3. Theoretical expectations from a successful model**

**John Huizenga [37] wrote a book,** with the viciously unscientific title, Cold Fusion: Scientific Fiasco of the Century. In this book he listed "three miracles", which must be satisfactorily answered by any theory of cold fusion. The three miracles are

**T1./ much enhanced tunneling through Coulomb barrier,**

T2./ suppress p + t, and n + 3He pathways to make 4He + gamma,

T3./ disappearance of 24 MeV.

According to him these miracles are impossible. Analyzing the experimental observations of LENR, Edmund Storms [38] put together a list or facts, what any theory must be answered.

T4./ (Fact #1) Helium is generated without significant radiation

T5./ (Fact #2) The effects are occur either light hydrogen or deuterium

T6./ (Fact #3) Tritium is produced without significant neutrons or radiation

T7./ (Fact #4) Helium -3 is not produced as a primarily product - eliminating p + d fusion

T8./ (Fact #5) Transmutations occur with either light hydrogen of deuterium

T9./ (Fact #6) Reactions occur at special localized sites

Thus any successful theoretical model on one hand must be consistent with the required experimental conditions for successful reaction, and on the other hand must satisfactory explain or answer the theoretical obstacles raised by the current interpretation and understanding of the fusion process.
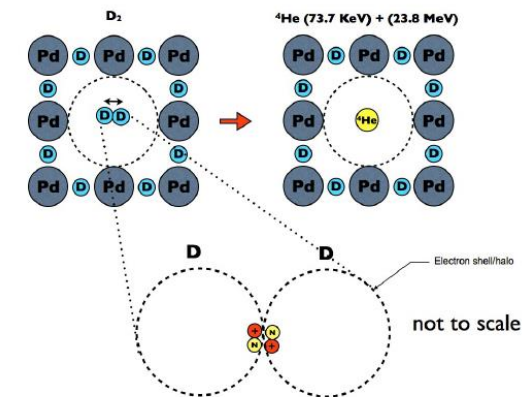


Figure 2 Schematic figure of the reaction. The Deuterium molecule is in a mono-vacancy. The loading of the surrounding Palladium is 0.9 or higher preventing diffusion. The vibration of the lattice triggers the vibration of the deuterium molecule. Close encounter of the two deuterium nucleus can result in fusion, producing 4He. The energy of the fission produces electromagnetic radiation, which dissipates in the lattice.

T9./ "Reactions occur at special localized sites"

The theoretical requirement T9 address the observations reported in E10. Experiments showed that the heat production is localized, like hot spots, which are associated with mini explosion [36]. **This observation is consistent with the proposed cavity vibration of D2 model.** The reaction is a random event, occurring in isolated vacancies. These isolated events does not induce chain reaction. **This might be the reason behind the reproduce-ability problem.** The combined outcome of the isolated events is the production of extra heat, which can be a tool to enhance the reaction. It is concluded that the presented simple electronic shell description of the atoms, along with the physical model, vibrating D2 molecule in the cavity or mono-vacancy of Palladium, offers a feasible explanation for the LENR experiments (Fig. 2).

# Laser Stimulation Of Deuterated Palladium: Past And Present
## Dennis Letts

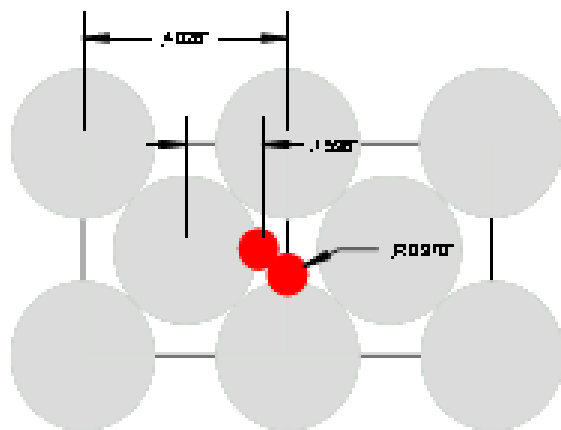**12015 Ladrido Ln,
Austin, Texas USA
E-mail: lettslab@austin.rr.com
Dennis Cravens
P.O. Box 1317
Cloudcroft, NM 88317 USA
E-mail: dennis@physics.tularosa.net**

Laser Stimulation Of Deuterated Palladium:
Past And Present Dennis Letts 12015 Ladrido
Ln, Austin, Texas USA E-
mail:lettslab@austin.rr.com
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Hydrogen In Surface Palladium Lattice
Scale: 1" = 1 Angstrom

Figure 12

## 8 Crude Model
A crude model has been proposed by one of us (Letts); its only redeeming quality is that it does provide a method to tune the laser. The wavelengths produced by the model have worked in the laboratory but there is no physical reason why they should work, other than luck. For discussion purposes, please consider the graphic shown in Figure 12.

D2 in metal

# New model of coulomb force is needed

## =>Electron Deep Orbits of the Hydrogen Atom

**Laser Stimulation Of Deuterated Palladium: Past And Present**
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## 8 Crude Model

A crude model has been proposed by one of us (Letts); its only redeeming quality is that it does provide a method to tune the laser. The wavelengths produced by the model have worked in the laboratory but there is no physical reason why they should work, other than luck. For discussion purposes, please consider the graphic shown in Figure 12.

### Figure 12

The model used to compute a resonant laser wavelength i[s] a-Box, found in all basic quantum mechanics textbooks. T[he] Deuterium can be localized in the open space between Pal[ladium] thus forming a two or three dimensional quantum well. Th[e] Deuterated Palladium are well known, as is the Palladium- distance. The quantum well dimension is then:

Eq. (1) L = beta phase lattice parameter – 2* Pd-D equilibri[um]

= 4.026 Angstroms – 3.072 Angstroms

= .954 Angstroms.

The quantized energy levels for Deuterium localized in the dimension L are computed according to:



Here can Be T site

Hydrogen In Surface Palladium Lattice
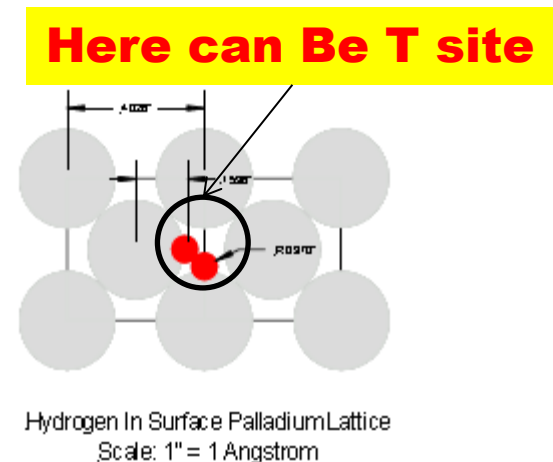Scale: 1" = 1 Angstrom

Figure 12

# What is the resonant frequency in T site???

**h is Plank's constant, mass is the mass of Deuterium and L is the dimension of the quantum well**

**There are only a few sets of numbers that will work; quantum numbers of (10,8,1) or (12,4,2) will yield resonant laser wavelengths of <span style="color:red">679.91 nm and 684.83 nm</span> respectively.**

Eq. (1) L = beta phase lattice parameter − 2* Pd-D equilibrium distance
= 4.026 Angstroms − 3.072 Angstroms
= .954 Angstroms.

The quantized energy levels for Deuterium localized in the quantum well of dimension L are computed according to:
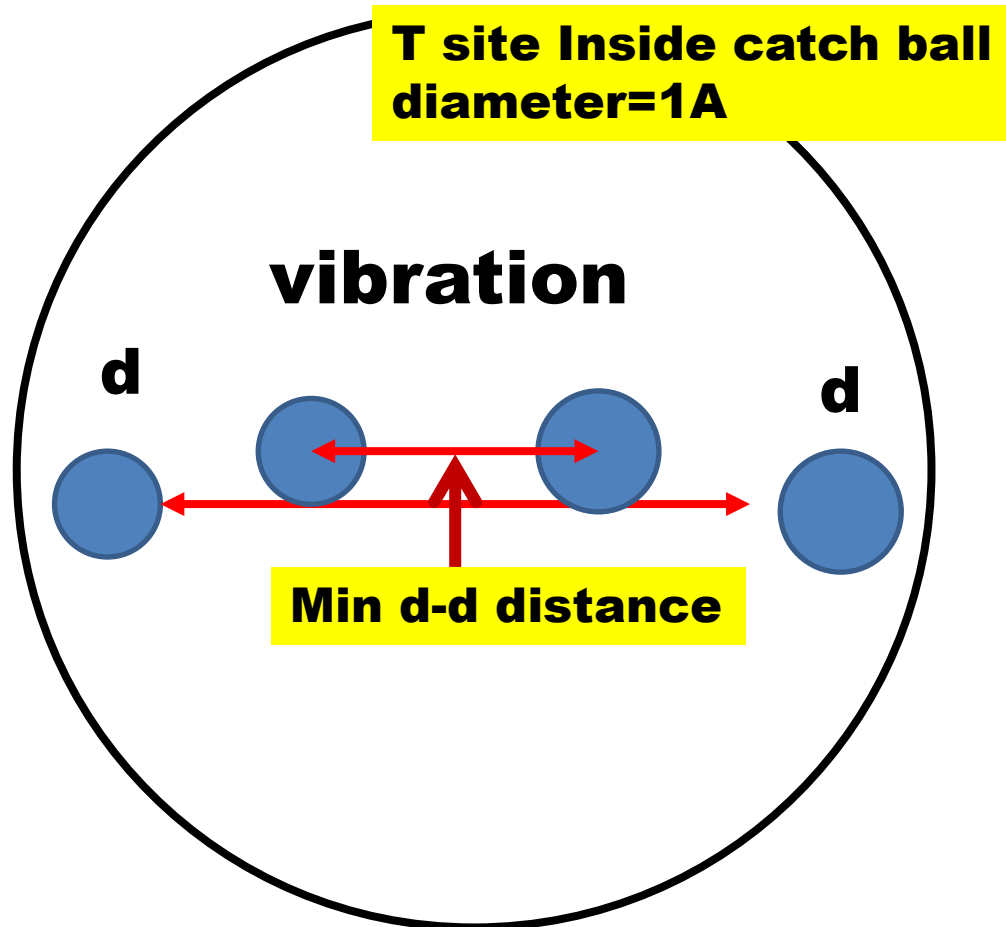
Eq. (2)

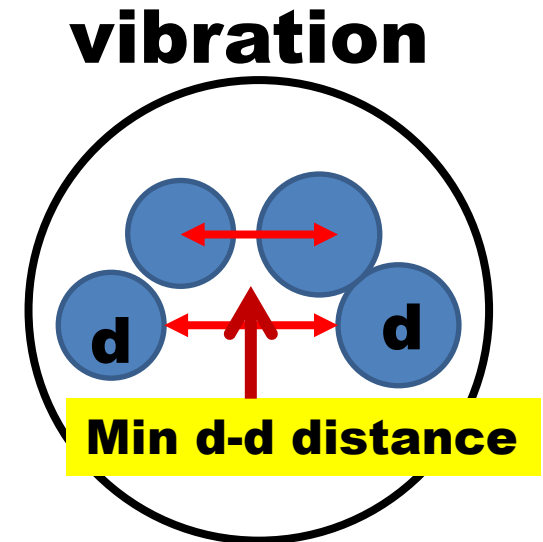$$E_{final} := \left( N_x^2 + N_y^2 + N_z^2 \right) \cdot \frac{h^2}{8 \cdot mass \cdot L^2}$$

Eq.(3)

$$E_{initial} := \left( 1^2 + 1^2 + 1^2 \right) \cdot \frac{h^2}{8 \cdot mass \cdot L^2}$$

# Cavity=(Expanded T site)

# Cavity=(T site)

**T site Inside catch ball diameter=1A**

**vibration**

d

d

**Min d-d distance**

**vibration**

d

d

**Min d-d distance**

T site size is smaller the fusion probability is higher but it is not easy to have the very narrow d-d distance by the stress of Pd atoms, so it is necessary to have the larger energy of D.

Min d-d distance is smaller with larger d-d vibration energy.
Frequency to the vibration is higher,
So the possibility of fusion is larger in the smaller cavity.

From the estimation of force from Pd atoms, it is impossible to make d-d distance on the order of fm.
So the shielding of coulomb repulsive force between d-d is needed from the paper of

# 常温核融合昨今 (Recent ColdFusion)

深井有

ところで金属・合金の中には水素を多量に固溶するものがある. Pd も古くから知られたその種の金属であって, H, D 原子の溶解熱は図1のような濃度依存性を示す. すなわち, 濃度 H, D/Pd～0.83 以下では水素分子が解離して固溶する際にエンタルピーが減少するので発熱が起り, それ以上の濃度では逆に水素が放出されるときに発熱が起ることになる.

問題は, こうして固溶した重水素の原子核同士を金属中で 0.015 nm という距離に近づけて保持できるかということになるのだが, これが不可能であることは極めて一般的に示すことができる.[13] そのためには, まず自由空間にあ

さい. Pd 結晶格子にはこのような近接原子対を保持する力はないのである. 実はこのような力を持つ固体は地球上には存在しない.

エネルギーの観点からも同じ結論に到達する. 金属中でばらばらに存在する2個の重水素原子核から r=0.015 nm の dd 対を作るとすると, これは約 40 eV という高いエネルギー状態になるので, 実際には核間距離が大きくなり周囲の格子が緩和して（場合によっては格子欠陥を生成して）より低いエネルギー状態になってしまうのである. 反応 (I～IV) のような2体反応ではなく, 多体反応の可能性が言われることもあるが, そのような配置のエネルギーはさらに高くなるので全く問題にならない.

最後につけ加えておきたいのは, 金属中を運動する荷電粒子は伝導電子との相互作用で急速にエネルギーを失って

ギー差から −46.9 eV と求められ, r にはあまり依存しない. 金属中では $V_0$ の値が溶解熱（の2倍）だけ変化するが, このような短距離では伝導電子による遮蔽は効かないので,[14] r 依存性はほとんど変らないはずである. そこで上式から水素原子核間のクーロン反発力を概算すると, r =0.015 nm で $f \approx e^2/r^2 \sim 1 \times 10^{-6}$ N という値が得られる. 一方, Pd 原子間の力を弾性定数から概算すると約2桁小

金属中にある d 原子核に $D^+$ イオンを衝突させて dd 反応を起させる場合, 通常は少くとも数 keV の加速を必要とするのだが, このような加速は金属中では行われず, 外で加速して打込む場合には反応は表面近傍に限られてしまうことになる. 電解電圧（≦数 eV）による内部での加速が問題にならぬことは言うまでもない.

ひとまず予備知識はこれだけでよかろう.

# Electron Deep Orbits of the Hydrogen Atom

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https://www.vixra.org/pdf/1605.0099v1.pdf

## Introduction

For many decades, the question of the existence of electron deep levels or electron deep orbits (EDOs) for the hydrogen atom led to numerous works and debates. Why once more a study on this subject? For several reasons:

- EDOs are predicted by relativistic quantum equations, with mean radius of the orbitals of order femto-meter.
- So, hydrogen atoms (including deuterium) with electron deep orbits (femto-atoms) can facilitate processes of LENR inside condensed matter, the avoidance of nuclear fragmentation in D-D => 4He fusion reactions, and a means of increasing the rate of energy transfer between an excited nucleus and the surrounding lattice
- Moreover, femto-atoms could create femto-molecules and combine with lattice nuclei for transmutation without energetic radiations.
- By accepting the reality of a non-singular central potential within a nuclear region, many mathematical arguments against anomalous solutions of the relativistic equations no longer pertain.
- Numerical methods now allow prediction of properties and features of the EDOs.

This means of overcoming the Coulomb barrier between nuclei is a continuing theme and is addressed in most models of LENR (see for example, "Extensions to physics: what cold fusion teaches," [5]). The other side of the problem was emphasized in 2013 (by Akito Takahashi at ICCF-15): "even if the Coulomb barrier were to be lowered to zero, D+D fusion would still lead to 4He-fragmentation products, not to the observed atomic 4He and heat of CF." This problem is perhaps best addressed by the means and consequences of electron decay to the deep orbits ("Tunneling Beneath the 4He∗ Fragmentation Energy,"[6] and "From the Naught Orbit to He4 Ground State" [7]).