EXPLAINING COLD FUSION

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What are we talking about?

(cold fusion [CF], LENR, CANR, LANR, CMNS, Fleischmann-Pons Effect)

A nuclear process initiated on rare occasions in apparently ordinary material without application of significant energy that generates heat and nuclear products without expected radiation when any isotope of hydrogen is present.

Basic Assumption #1

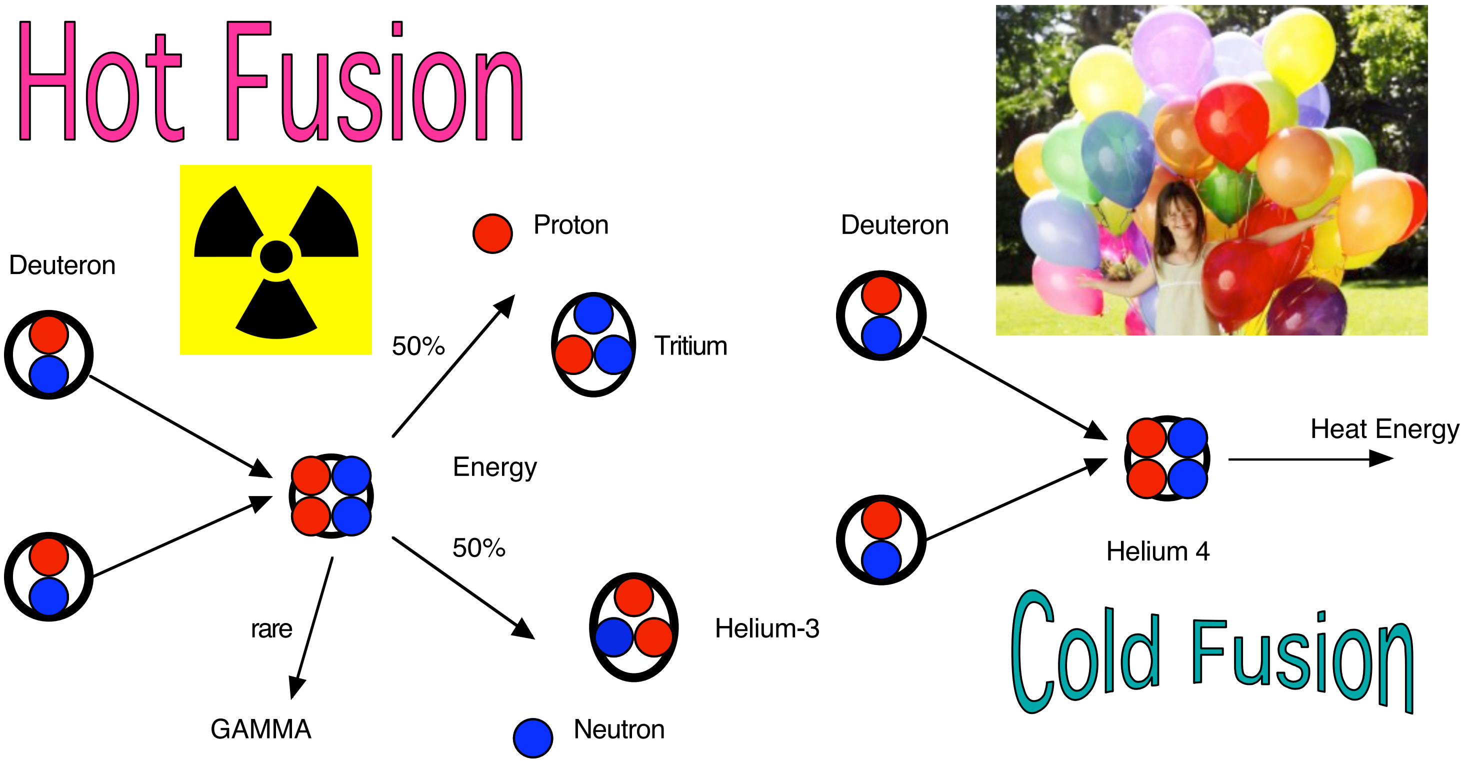
- CF **cannot** occur in a **"normal"** material but requires formation of a **unique** condition.
- This condition is rare, difficult to create, but can form in many materials.
- I call this condition the Nuclear Active Environment **(NAE)**.

Basic Assumption #2

- The heat energy and nuclear products are produced by the **same** basic process operating in the **same** NAE.
- This basic process applies to both transmutation and fusion using any isotope of hydrogen.

Basic Assumption #3

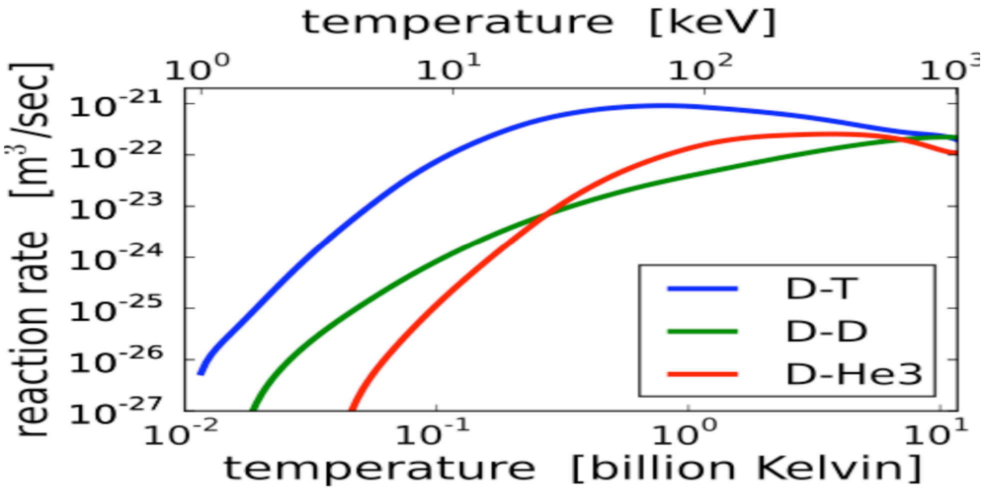
Cold Fusion is **not** Hot Fusion.

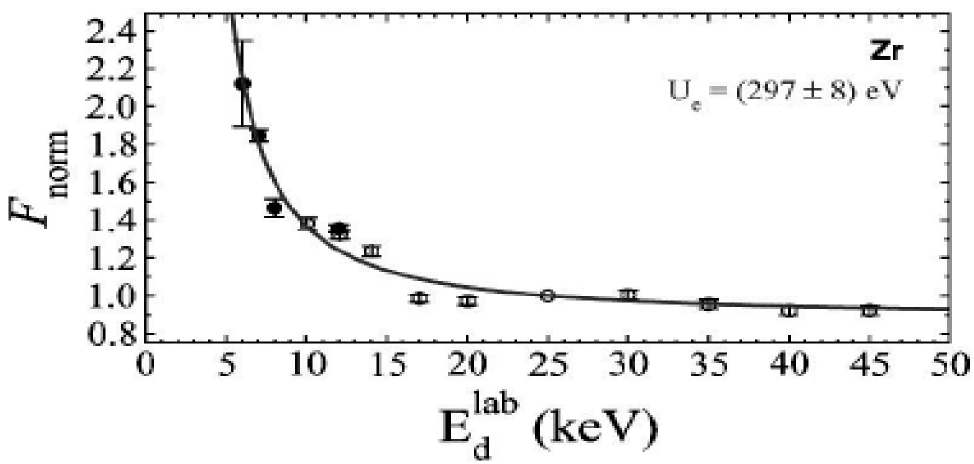


HOT FUSION

- Intense plasma in magnetic field (ITER)
- Laser induced plasma (NIF)
- Farnsworth fusor using electric field
- Bubble collapse fusion (sonofusion, sonoluminescence)
- Fractofusion (piezonuclear)
- Cavitation fusion
- Muon fusion (energy added as mass)
- Energetic ion bombardment

Effect of Applied Energy on Rate of Hot Fusion





- Rate of fusion in plasma (Wikipedia)

Heat of vaporization of Pd=362 kJ/mole = 3.8 eV/atom

- Excess rate using D^+ ion to bombard Zr (Huke et al. 2008)

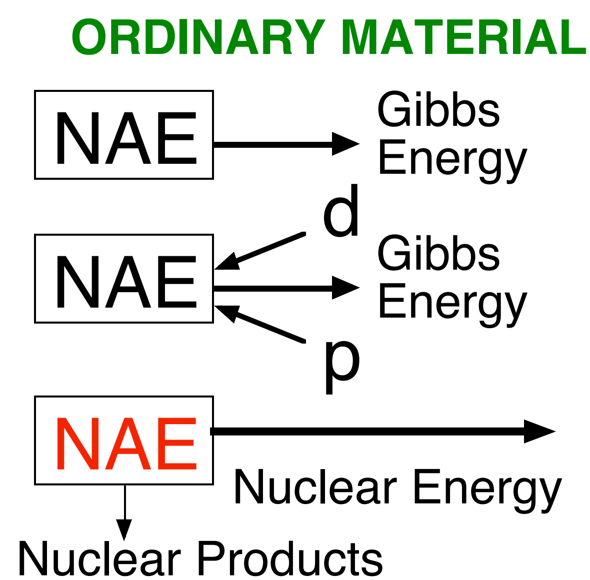
COLD FUSION

All proposed explanations need to apply to each method and the resulting behavior.

- Exposure of a material to electrolysis (F-P Effect)
- Exposure of a material to gas discharge
- Exposure of a material to sonic bombardment (Stringham Effect)
- Exposure of a material to plasma (plasma electrolysis)
- Exposure of a material to H_2 or D_2 gas (Arata Effect)
- Electromigration (oxides and metals)
- Simple diffusion through Pd

Basic Sequence of the CF Phenomenon

- NAE must be created.
- Hydrogen isotopes must be present.
- Hydrogen assembles in the NAE.
- A nuclear reaction occurs that emits mass-energy in small quanta.



Gibbs Energy

$$\Delta G = \Delta H - T\,\Delta S$$

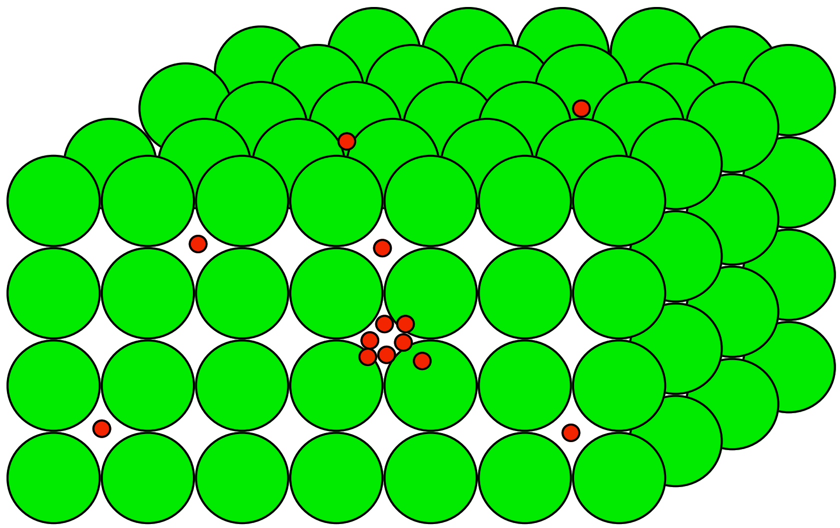
G= Gibbs energy (driving force)

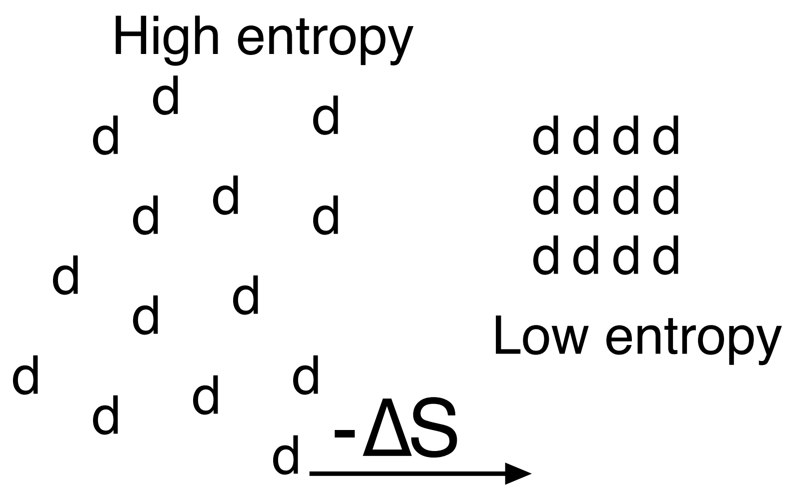
H = enthalpy (glue)

S = entropy (assembly energy)

T = temperature, K

Negative ΔG means Gibbs energy has been generated and lost from the material. A spontaneous change will only occur if Gibbs energy is generated by a process.





Second Law of Thermodynamics

Energy does not concentrate spontaneously.
Energy always moves from where it is larger to where it is smaller.

Law of Probability

The greater the number of events required to occur at the same time or in sequence for a process to take place, the less likely this process will occur in a unit of time.

Conservation of momentum

Every reaction that generates energy requires an equal and opposite reaction for the energy to be dissipated.

MY CONCLUSIONS

- No present explanation is consistent with all proposed requirements or all observed behavior.

THEREFORE the CHALLENGE is:

- Find an explanation using accepted laws and rules.
- Find an explanation able to explain all observations.
- Propose a way to test the explanation using easily tested predictions.
- Find an explanation based on the fewest ad hoc assumptions, all of which are clearly stated and justified.

Basic Features of Proposed Model

(Predictions in green)

- The NAE is a gap having a critically small size that is created by stress relief. The gap size is limited by the particle size in which it occurs.
- The hydrogen nuclei assemble in the gap and form a covalent bonded chain (Hydroton) with release of Gibbs energy, thereby stabilizing the gap.
- The chain resonates, which allows periodic emission in opposite directions of many weak coherent photons from each nucleus.
- The electron that reduces the Coulomb barrier is sucked into the final product nucleus after most energy is lost, whereupon a neutrino is emitted without significant energy.
- The nuclear reactions are:

Predicted Nuclear Reactions

- First unified model of separate proposals proposed by other people.(Romodanov, ICCF-10)
- Tritium production is key. (limited source)
- Tritium production is the easiest and least ambiguous behavior to test.

$d+e+d > {}^{4}H$ (fast decay) $> {}^{4}He + e$ ~24 MeV

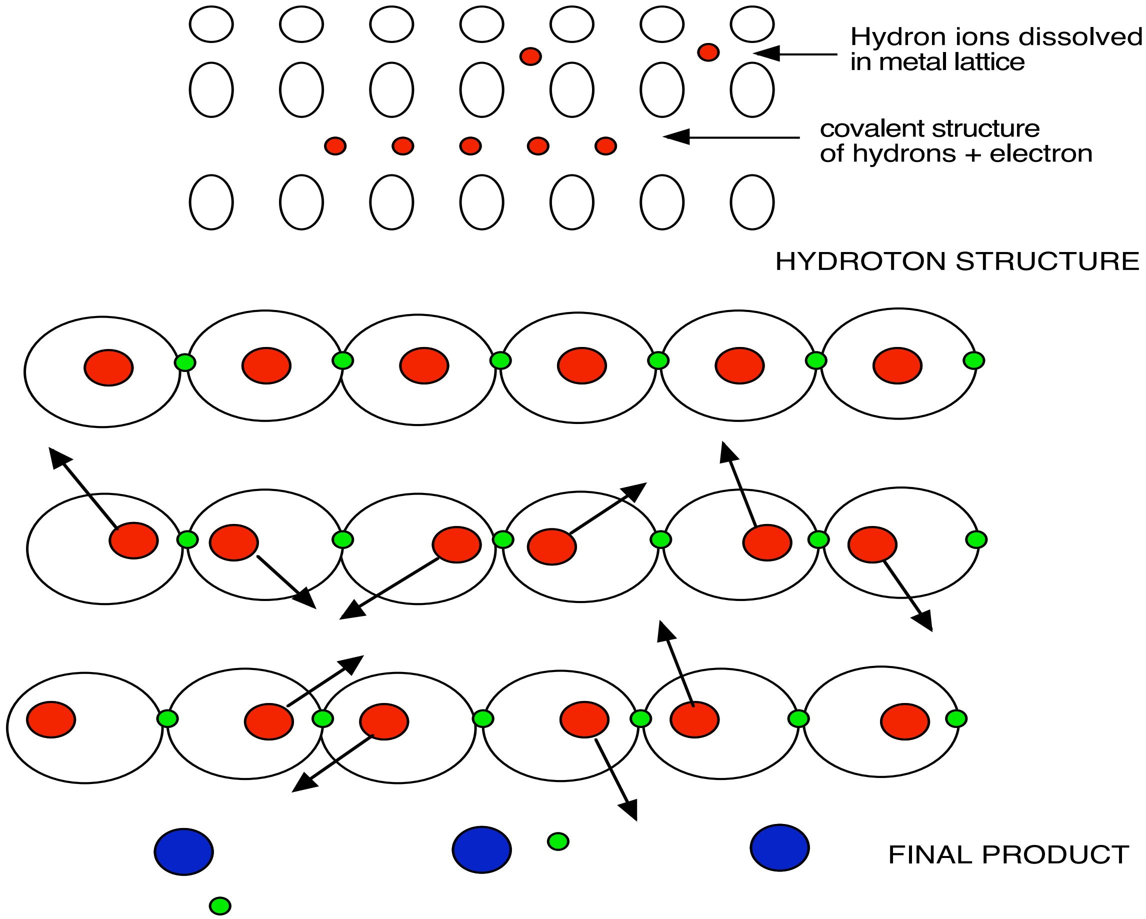
$d+e+p > {}^{3}H$ (slow decay) $> {}^{3}He + e$ ~4.9 MeV

$p+e+p > {}^{2}H$ (stable) ~1.4 MeV

$t+e+p > {}^{4}H > {}^{4}He + e$

$t+e+d > {}^{5}H > {}^{4}H + n > {}^{4}He + e$

Proposed Sequence



Predictions (scientific)

Assumption: CF is a single phenomenon related to other phenomena

- The Hydroton is metallic hydrogen (MH).

When metallic hydrogen is formed by subjecting H_2 to high pressure, a brief and intense nuclear reaction will produce heat and radiation when MH forms.

- The heat claimed by Rossi and others using $Ni+H_2$ does not result from transmutation, but from formation of deuterium.
- Tritium will be produced in increasing amount when H is used to initiate CF.

Predictions (engineering)

- Power = X*A*C*exp(-B/RT)

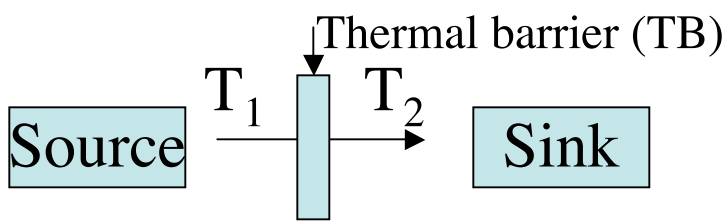
  X = constant related to isotope present,

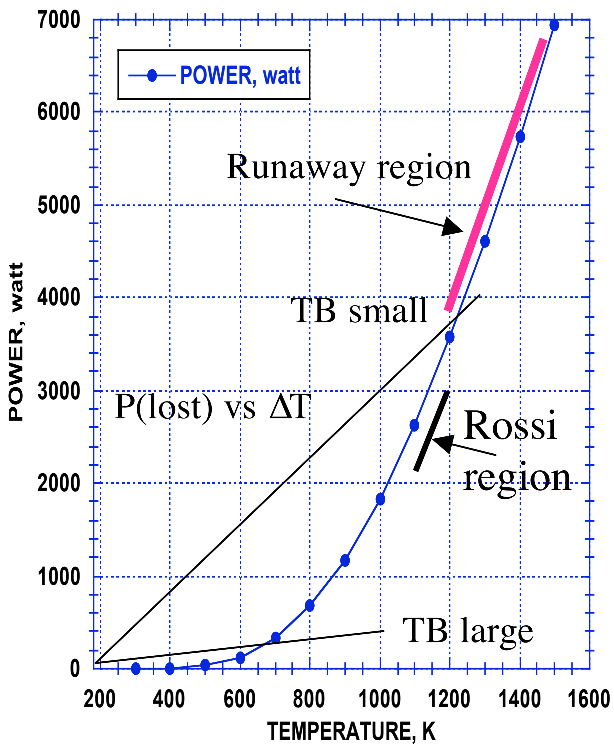
  A = number of NAE,

  C = concentration of hydrogen isotope in the material surrounding the NAE,

  B = energy required to move hydrogen within the material.

- Power production is stable when production ≤ loss
- Loss = (T_1-T_2) * (thermal conductivity)

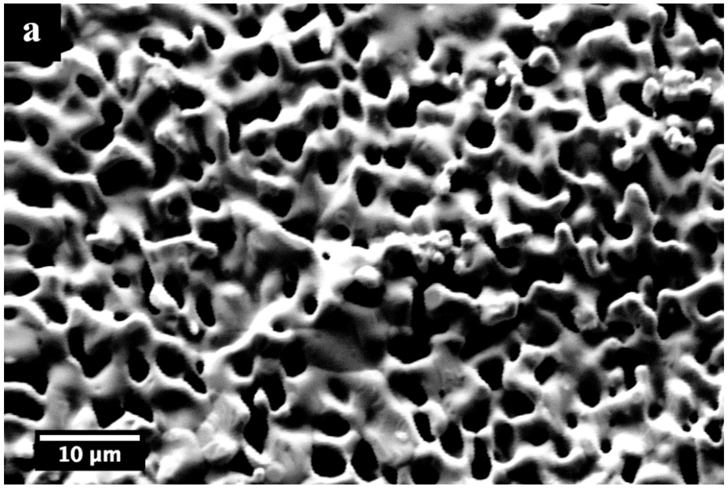




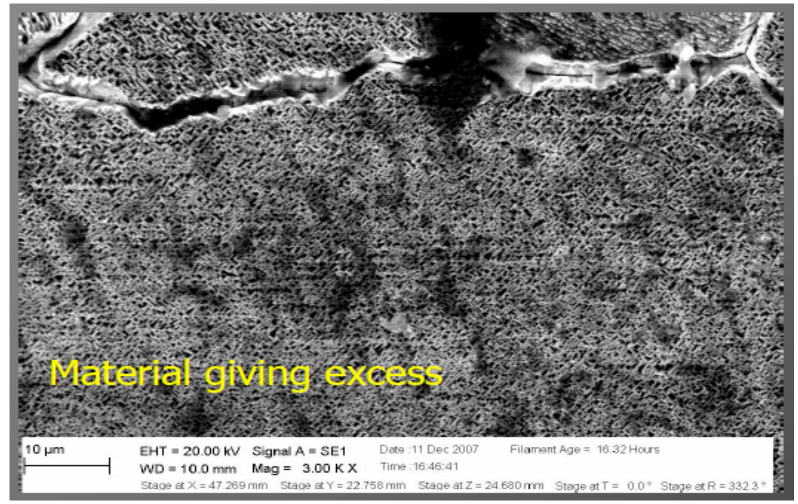
F-P first to show effect

Also applies to ^4He and ^3H production.

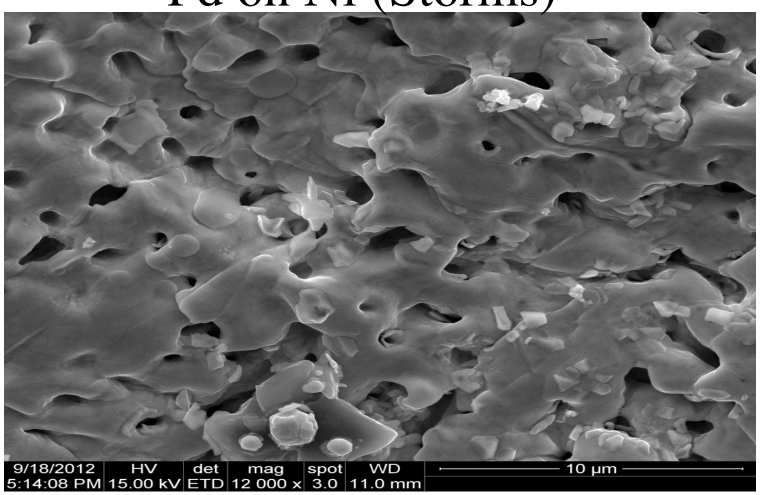
Pd heated in flame (Dash)



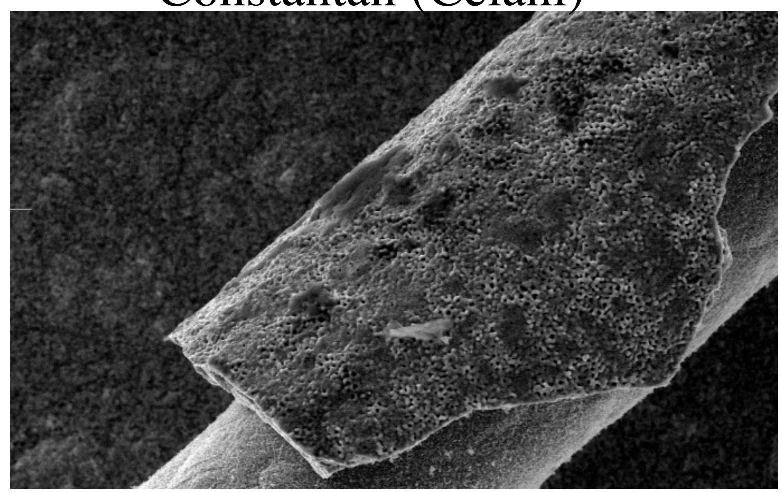
Pd (Violante et al.)



Pd on Ni (Storms)



Constantan (Celani)



Conclusions

- Cold fusion is real, not related to hot fusion, and requires a significant change in a material to occur.
- The present lack of progress is caused by lack of effective guidance to research, i.e. theory.
- All behavior of all materials using all isotopes of hydrogen can be explained by a single basic mechanism operating in a single NAE.
- The NAE is created as nano-gaps resulting from stress relief that is related to a common morphology in the surface region.
- The nuclear-active structure is metallic hydrogen that forms in the nano-gaps.
- Heat is generated by formation of ^{4}He, tritium, or deuterium, depending on which hydrogen isotope is present, accompanied in each case by emission of weak photon radiation.
- Transmutation results only as a consequence of a fusion reaction.

Energy rate and density

- d+d = ^{4}He, 24 MeV/event

1 watt= 2.6×10^{11} events/sec

10kW for 1 year = 0.54 gm D_2

- p+e+p = deuterium, 1.4 MeV/event

1 watt= 4.5×10^{12} events/sec

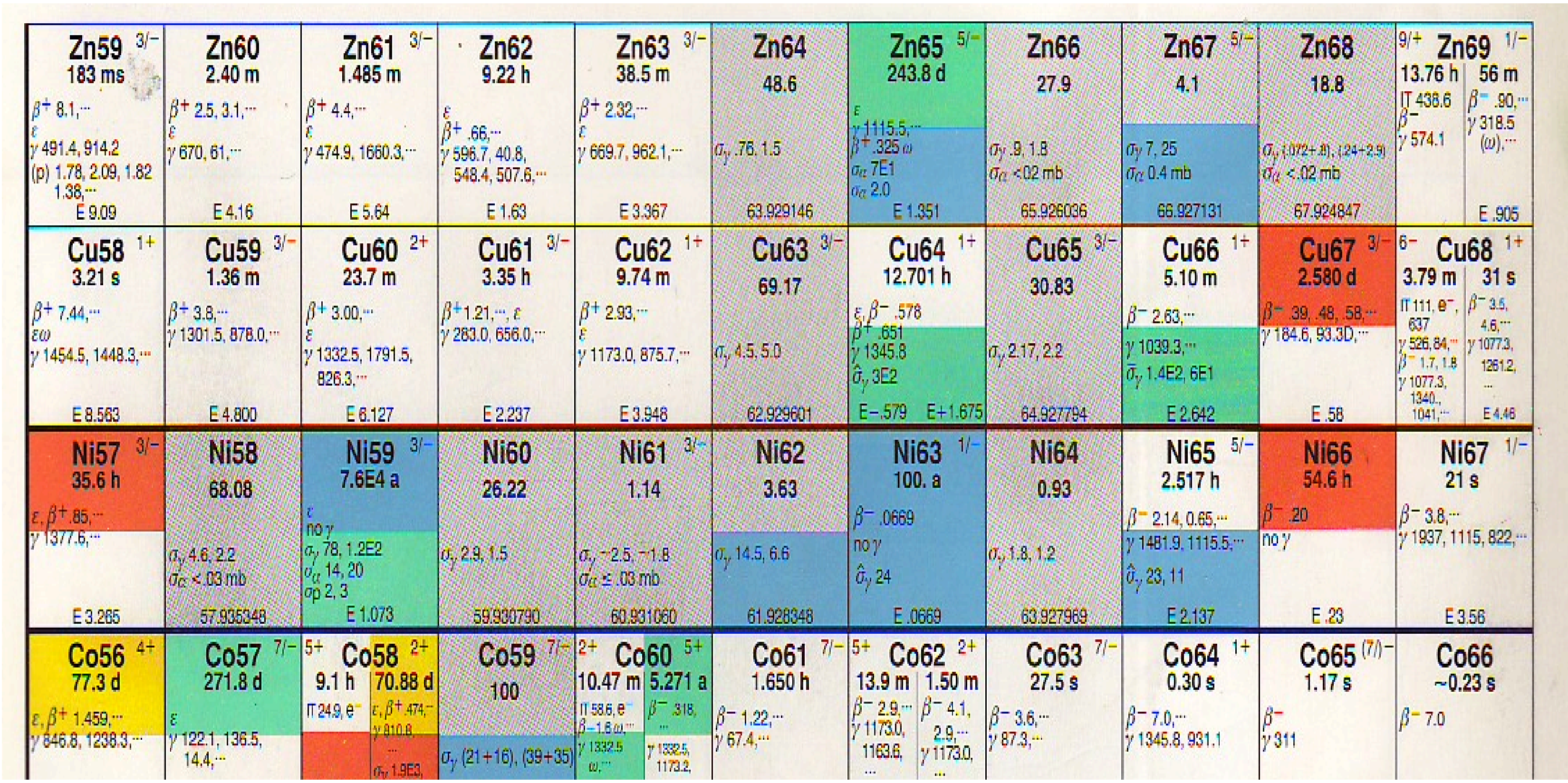
10kW for 1 year = 4.7 g H_2

- $^{62}Ni + p = {}^{63}Cu$, 6.1 MeV/event

1 watt = 1.0×10^{12} events/sec

10kW for 1 year = 31.0 g Ni

- D_2 = 58 $\times 10^{10}$ J/g
- H_2 = 6.8 $\times 10^{10}$ J/g
- Ni = $< 1.0 \times 10^{10}$ J/g



Zn59 3/− 183 ms
Zn60 2.40 m
Zn61 3/− 1.485 m
Zn62 9.22 h
Zn63 3/− 38.5 m
Zn64 48.6
Zn65 5/− 243.8 d
Zn66 27.9
Zn67 5/− 4.1
Zn68 18.8
Zn69 1/− 13.76 h 56 m
Cu58 1+ 3.21 s
Cu59 3/− 1.36 m
Cu60 2+ 23.7 m
Cu61 3/− 3.35 h
Cu62 1+ 9.74 m
Cu63 3/− 69.17
Cu64 1+ 12.701 h
Cu65 3/− 30.83
Cu66 1+ 5.10 m
Cu67 3/− 2.580 d
Cu68 1+ 3.79 m 31 s
Ni57 3/− 35.6 h
Ni58 68.08
Ni59 3/− 7.6E4 a
Ni60 26.22
Ni61 3/− 1.14
Ni62 3.63
Ni63 1/− 100. a
Ni64 0.93
Ni65 5/− 2.517 h
Ni66 54.6 h
Ni67 1/− 21 s
Co56 4+ 77.3 d
Co57 7/− 271.8 d
Co58 2+ 9.1 h 70.88 d
Co59 7/− 100
Co60 5+ 10.47 m 5.271 a
Co61 7/− 1.650 h
Co62 2+ 13.9 m 1.50 m
Co63 7/− 27.5 s
Co64 1+ 0.30 s
Co65 (7/)− 1.17 s
Co66 ~0.23 s