"Do not be alarmed...I am the cold fusion fairy."

Experiment, Results, and Theory for Nuclear Reactions in Deuterium Loving Metals

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What sort of fusion are we talking about?

We started this talking 16 years ago yesterday!

COLD FUSION

SOLID STATE FUSION

LENR - (Low Energy Nuclear Reactions)

CANR - (Chemically Assisted Nuclear Reactions)

You name it.

It's fusion!

I Prefer the Name - Solid State Fusion

- Occurs only in solid matter especially in hydrogen loving metals including palladium and titanium
- Not a uniform bulk reaction in all regions of such metals
- Deuterium is the preferred isotope of hydrogen for the fusion yielding 4He as the primary end product
- NO significant neutrons have been reproducibly observed
- NO energetic gammas or x-rays have been observed
- Some tritium is observed but at much reduced rates when compared to 4He

Modalities

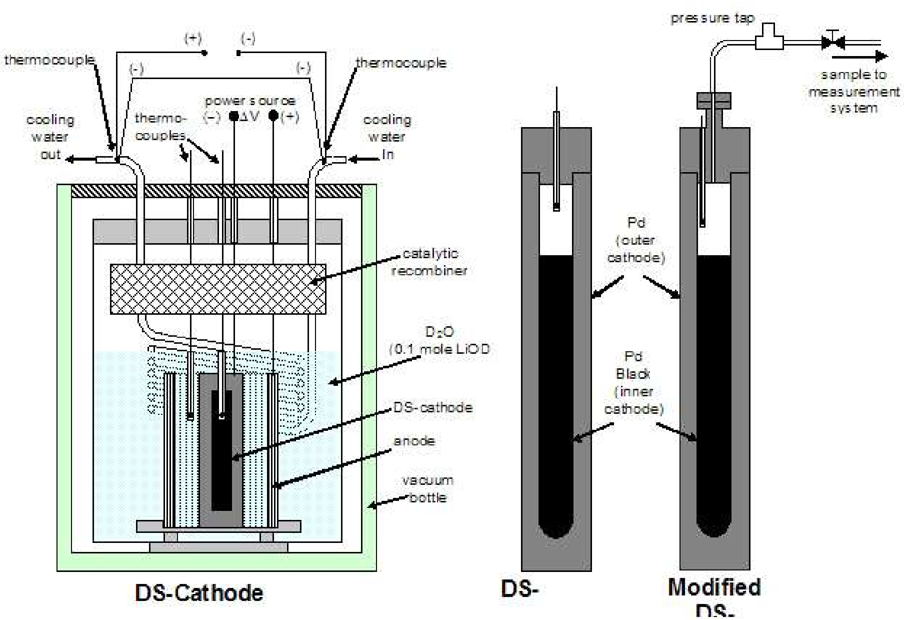
- There are a variety of modalities for reliably creating solid state fusion
- Electro-chemistry (we have a mantra in our company that says avoid electrochemistry like the plague)
- Glow Discharge
- Nano Particle Gas Phase
- Sono Fusion – via cavitation in deuterated liquids
- We practice the latter three

Solid State Fusion in Nano Materials

- Nano-lattices of certain metals provide for and exhibit coherent behavior by populations of deuterons (D's) occupying a Bloch state.
- The Bloch condition reduces the Coulomb barrier. Resulting overlap of DD pairs provides a high probability fusion will/must occur.
- Solid-state DD fusion leaves an excited 4He nucleus entangled in a coherent population of D's coupling energy of fusion over many D's and metal atoms yielding 4He and heating.
- This contrasts with plasma DD fusion in collision space where an isolated excited 4He nucleus must seek the ground state via fast particle emission.
- In momentum constrained solid state fusion, fast particle emission is effectively forbidden.

Nano-Particle Fusion

- Two protocols have yielded anomalous heat, helium, and tritium
- Both are characterized by nano-particles of Palladium
- Both operate in gaseous Deuterium at low temperature



ARATA Double Structure
Hollow Powder Filled Cathode

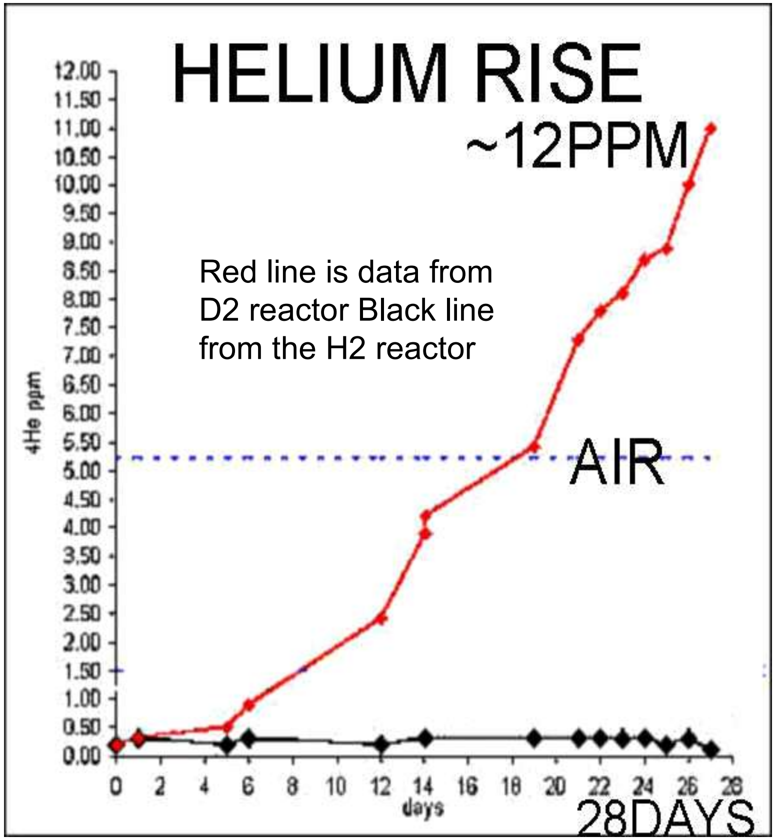
D2FUSION Pd Catalyst Device

Helium from Nano-Particle Pd

- In experiments conducted at SRI using instruments built by this author and attached to a high quality Extrel Quadrapole Mass Spec provided by the Electric Power Research Institute real time on-line helium was observed in a D2 Pd nano-particle gas phase experiments. In an identical simultaneous control experiment using H2 no helium was observed.

- Approximately 0.9 watts of anomalous heat was produced which is roughly commensurate with the helium observed if D+D ? 4He @23mev

Lab and Results For Pd Catalyst Reactor Test



BLOCH STATES:
NOT FOR ELECTRONS ONLY

- It is often essential to consider an electron traveling through a solid as being a wave that spreads out through the whole of the solid. The quantum description of this spread-out electron was formulated by Felix Bloch in the 1920s.

- Physicists have since sought to extend this idea of a "Bloch state" to guest atoms in a crystal, but an atom's mass is so large (and its equivalent wavelength so small) that a Bloch state for an atom has been difficult to observe, especially in ordinary materials.

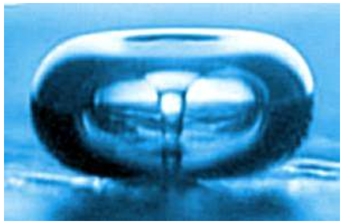
- Physicists have seen clear signs of Bloch state atoms in proton conducting materials.

- When we can create Bloch state hydrogen in metals pairing of nuclei can and does occur. Such pairs may be analogous to Cooper Pairs wherein we know the Coulomb repulsion is altered.

Nano-domains offer ideal Bloch Conditions for Hydrogen

- Because the wavelength of a proton or deuteron in a metal lattice is very small a Bloch-like wave may be optimally established in very small domains, some few tens of nanometers in diameter
- Such nano-domains do not ordinarily occur in metals as lattice features in metals are usually in the micron dimension (1000's of nm)
- When such domains are loaded with deuteron pairs will fuse with greatly enhanced rates
- Optimally in materials where this dimensional size range is created intentionally solid state fusion will appear at significant rates
- In ordinary metals such domains do rarely occur due to working and fracture of larger lattice domains, this explains both the observation of cold fusion by Fleischmann and Pon's and the problem reproducing their results in ordinary palladium metal.

SONOFUSION - A Second Method



- Using ultrasound driven asymmetric cavitation of bubbles in D2O on can both dramatically work and fracture lattices and simultaneously load those fractured lattices with Deuterium

- Again this author has conducted such experiments using one off apparatus.

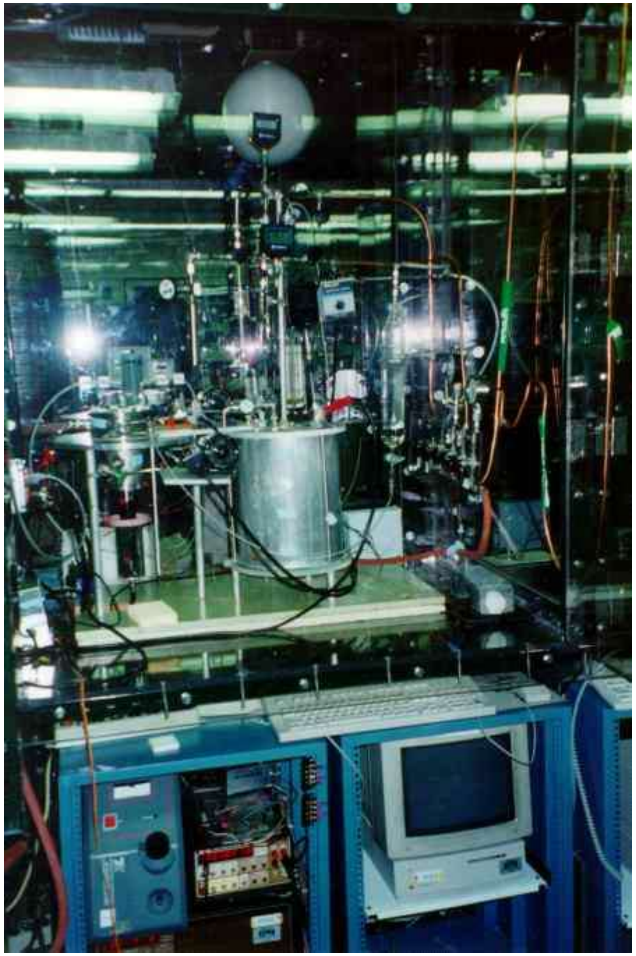
- The apparatus uses a simple piezo ceramic transducer to produce intense cavitation similar to that formed in common ultrasonic cleaning devices.

- When deuterated liquids are chosen the result is anomalous heating and again the production of helium

- No measurable energetic emissions are observed

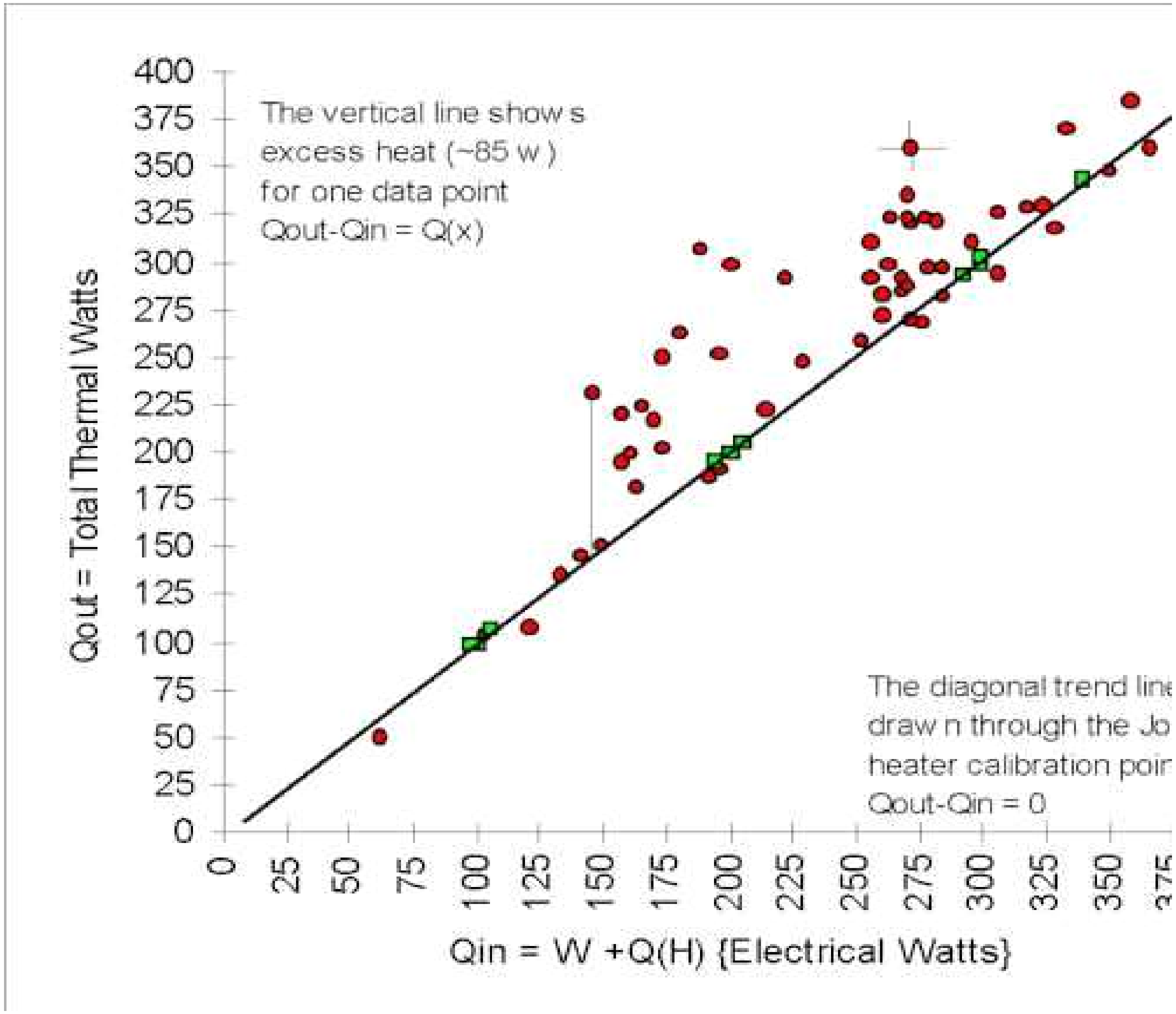
- The heating is dramatic!

Sonofusion Devices Operated by Russ at SRI and University of Osaka



Device on left is the Mark II Reactor - Device on right is the Mark IV

Heat Results from Sonofusion Device Operated Under Contract with EPRI



Further Evidence of Heating by Sonofusion

Palladium Metal Target
100 microns thick 5X5cm

Palladium melts at ~1600 C

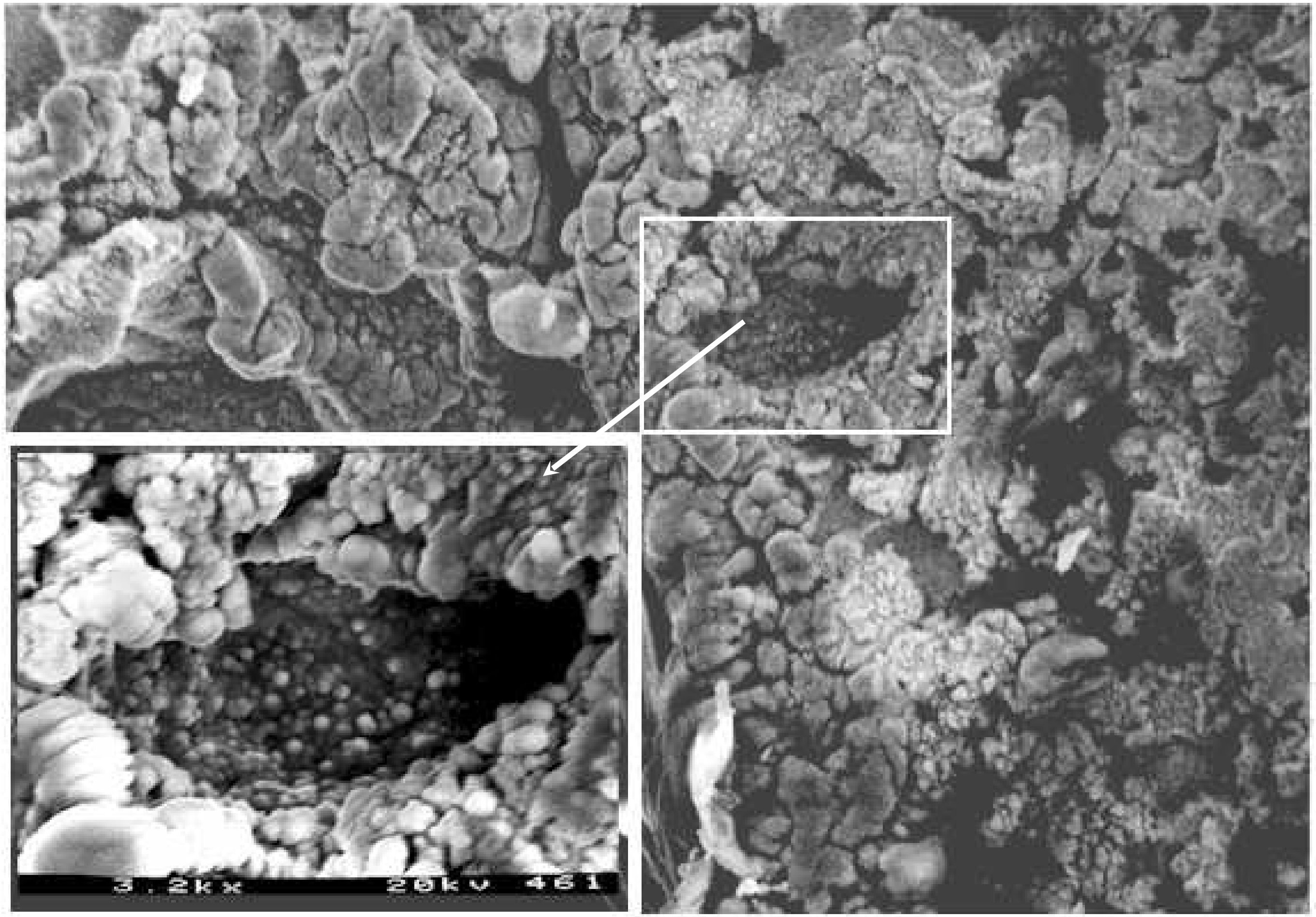
This metal was immersed in rapidly circulating heavy water maintained at a temperature between 50-80 C

Melting clearly occurred but via micro-sites over a period of hours

Examination of the metal (active and inactive regions) by vaporization and helium mass spectroscopy revealed greatly enhanced concentrations of 3He and 4He in the active metal

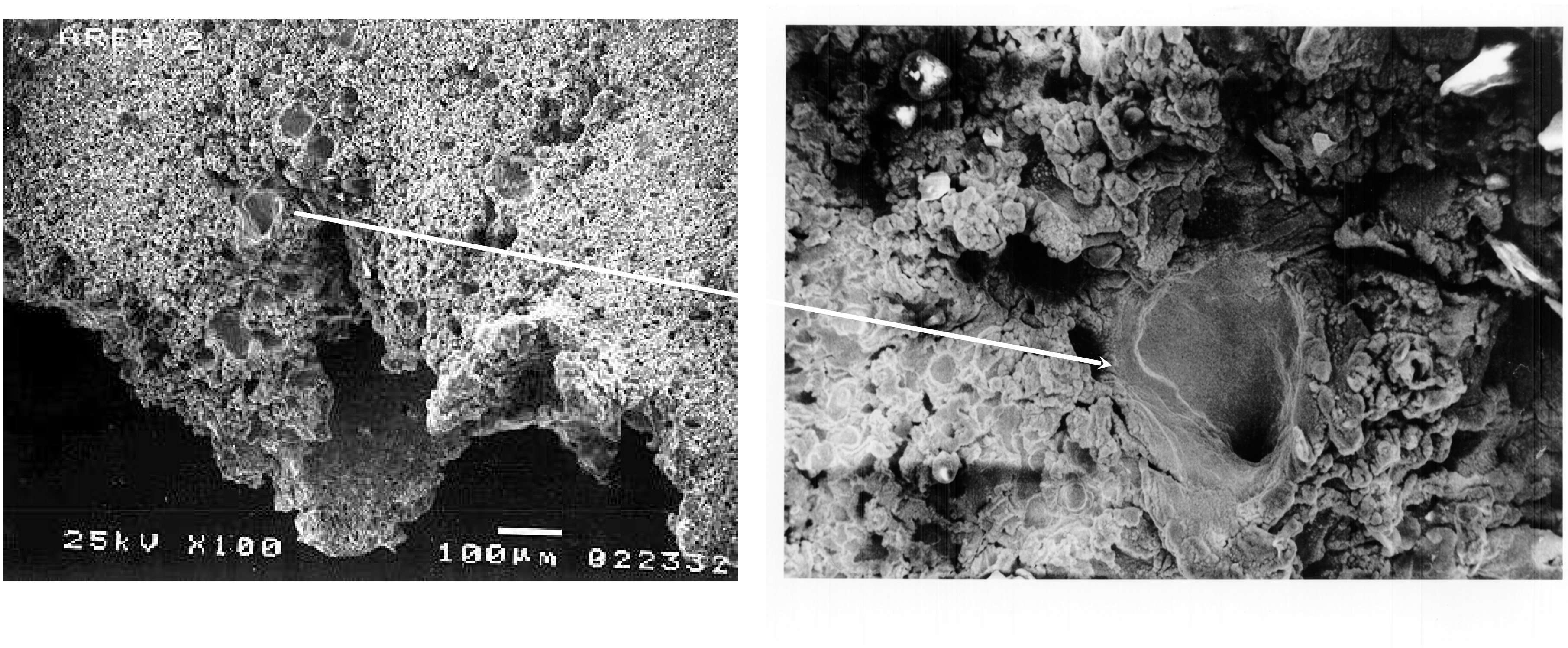
Sono/Micro Fusion Melting

Micro Volcanos are seen with sputtered fragments under SEM

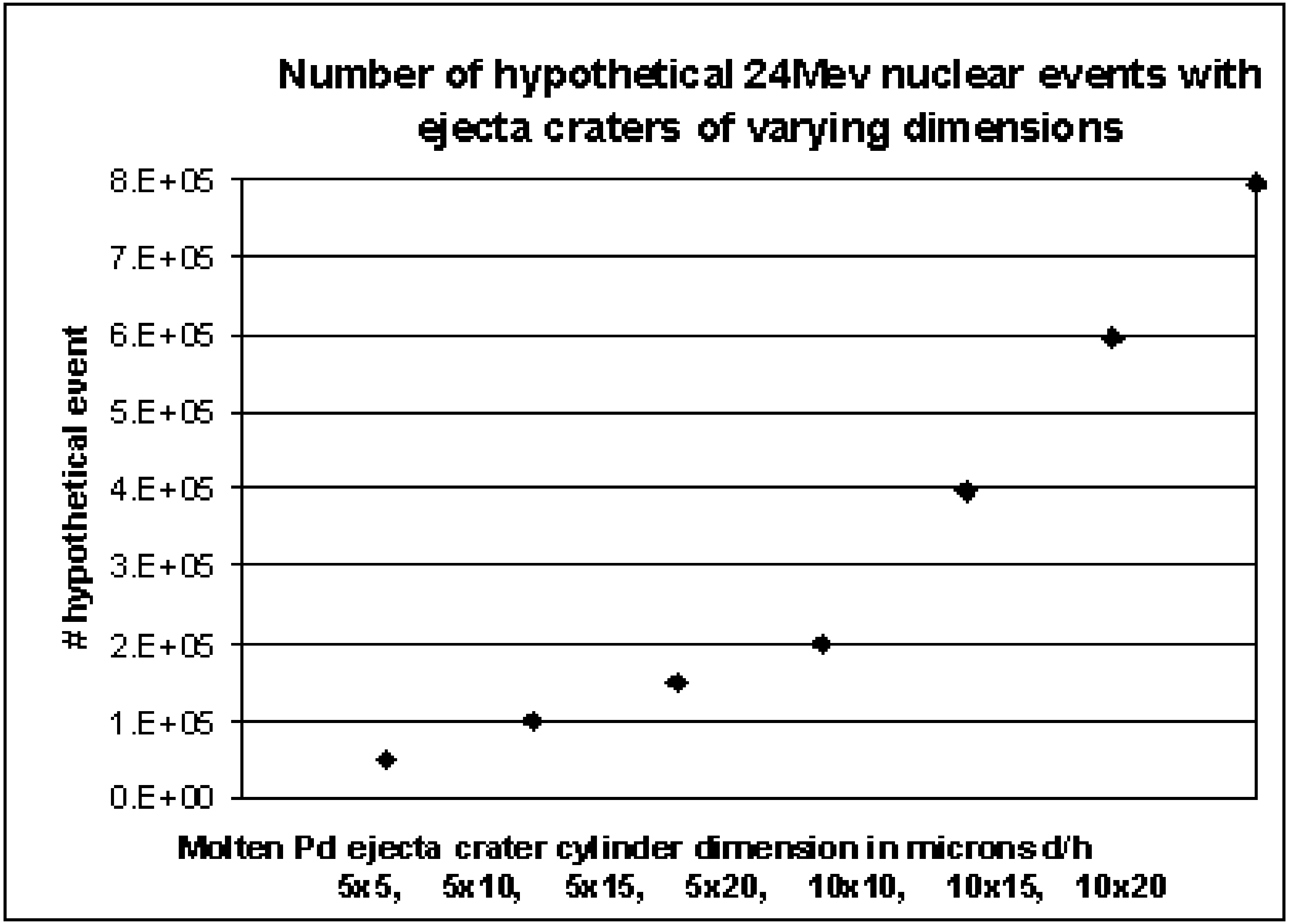


Sono/Micro Fusion Melting

Micro volcanoes with glassy surfaces are seen under SEM



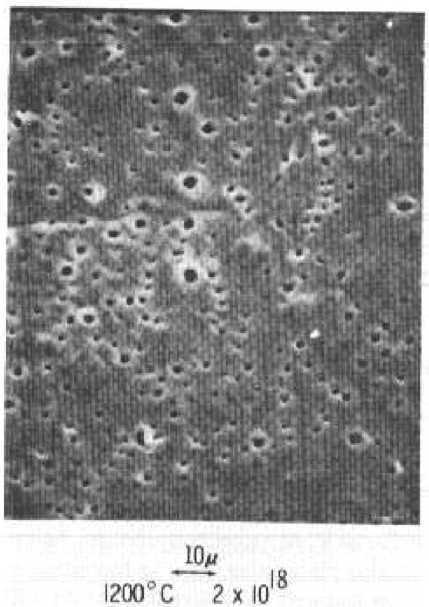
Energy To Create These “Volcanoes”

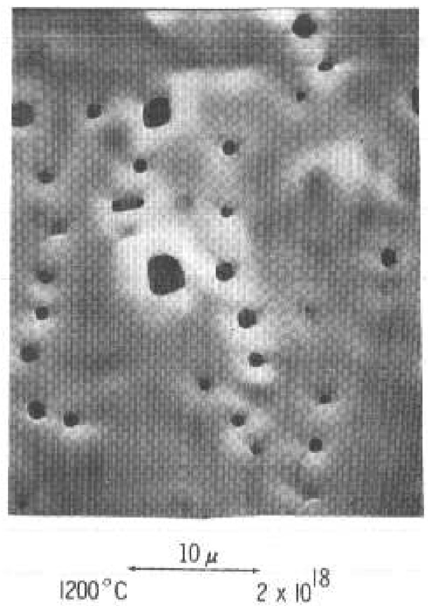


These Volcanic Ejecta Features Are Otherwise Observed ***ONLY*** in Fissioning Heavy Metals

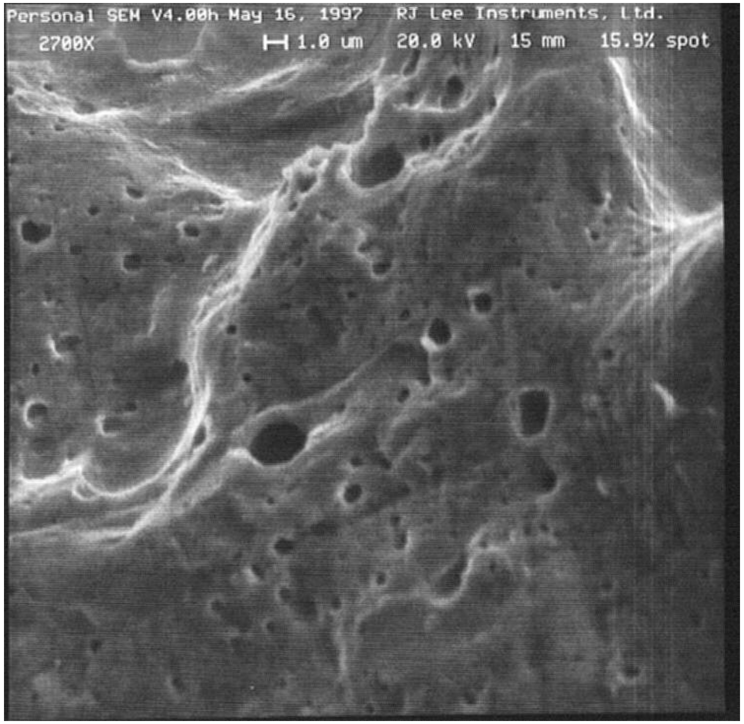
- Some References
- M D Rodgers, "Mass transport and grain growth induced by fission fragments in thin films of uranium dioxide," J. Nucl Materials 15, 65-72 (1965)
- B V Ershler and F S Lapteva, "Evaporation of metals by fission fragments," J Nucl Energy 4 471-474 (1957)
- G Nilsson, "Ejection of uranium atoms from electropolished foils of uranium metal by fission fragments," J. Nucl Materials 20 231-235 (1966).
- P J Peterson & M M Thorpe, "Comparative measurements of uranium atom emission from fissioning surfaces," Nucl Sci & Energy 29 425-431
- (1967)
- J P Bierstock, "Sputtering and chunk ejection from UO2 and metallic layers deposited in UO2," J Nucl Materials 53 194-200 (1974)

More Evidence – Classical "Loop Punching" Helium Bubbles Form in Cold Fusion Palladium





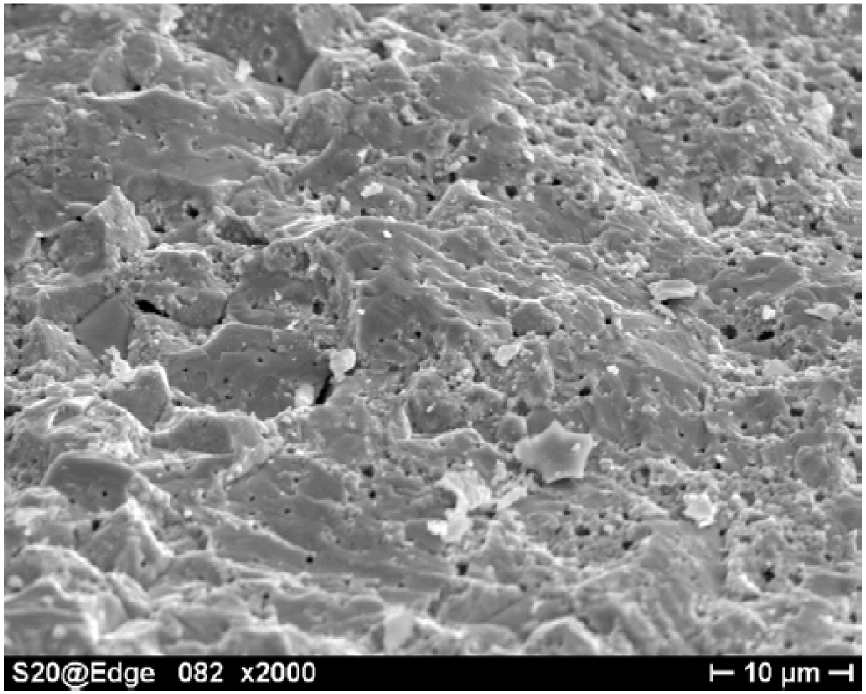
Scanning electron micrographs of vanadium implanted with He at three different temperatures to the indicated flue



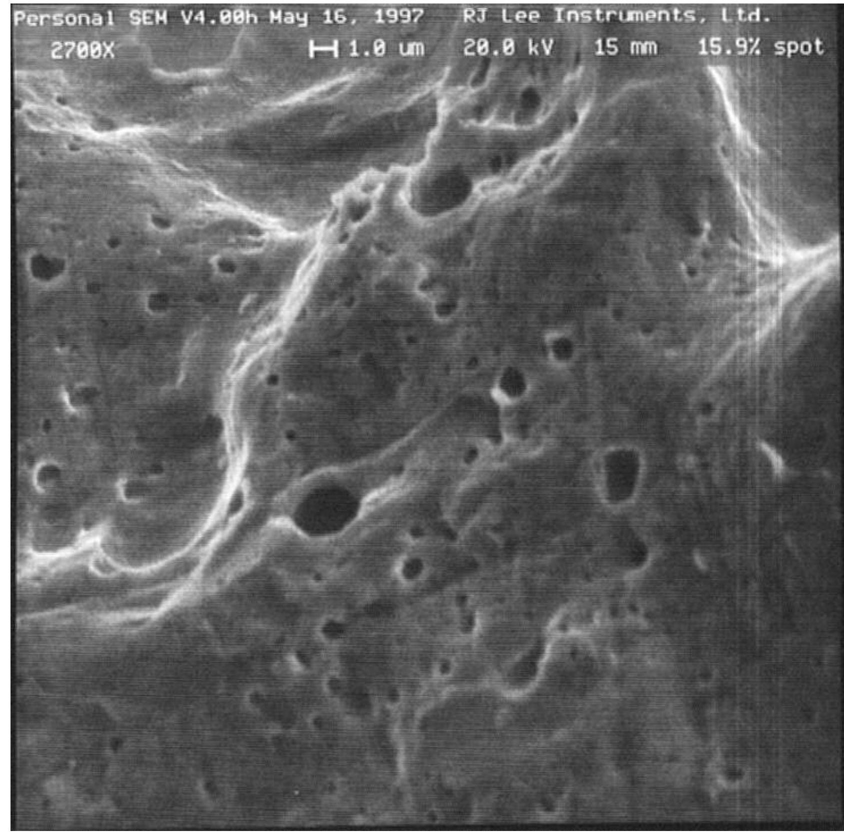
Helium Bubbles in Neutron Irradiated Metals. The helium forms as a result of N Alpha reactions.

Similar "helium bubbles" in palladium from sonofusion experiments with D2O. Helium forms from DD fusion.

Uranium Fuel Metal High Pu



SEM : Fracture



Uranium Fuel with helium bubbles

Sonofusion Palladium with helium bubbles

Glow Discharge

- For a number of years and especially at present we have been working on cold cathode cold fusion in a glow discharge environment.

- This ongoing work uses a variety of configurations and is producing some promising results from ultra-low power glow discharge.

- We will soon begin testing of some of these devices for nuclear product signatures focusing on the quantification of tritium production rates.

- By understanding the reaction pathways that yield tritium we hope to understand how to avoid it in commercial applications.

Summary

- Solid State / Cold / Nano / Sono Fusion is robust and reliable.
- Key nuclear reaction products are clearly shown including helium, tritium, and classical nuclear reaction metal fingerprints.
- Solid State fusion is the more apt description term as conventional solid state theory is both predictive and descriptive of the conditions required and observations.

What's Next

- D2FUSION Inc. has been formed and funded to develop solid state thermal modules suited for a wide range of applications beginning as small scale distributed heat sources

- Our work will proceed with the participation of a number of the worlds most noted fusion scientists and laboratories.

- We plan to develop and deliver our first prototype thermal modules over the course of the next year

- For further information

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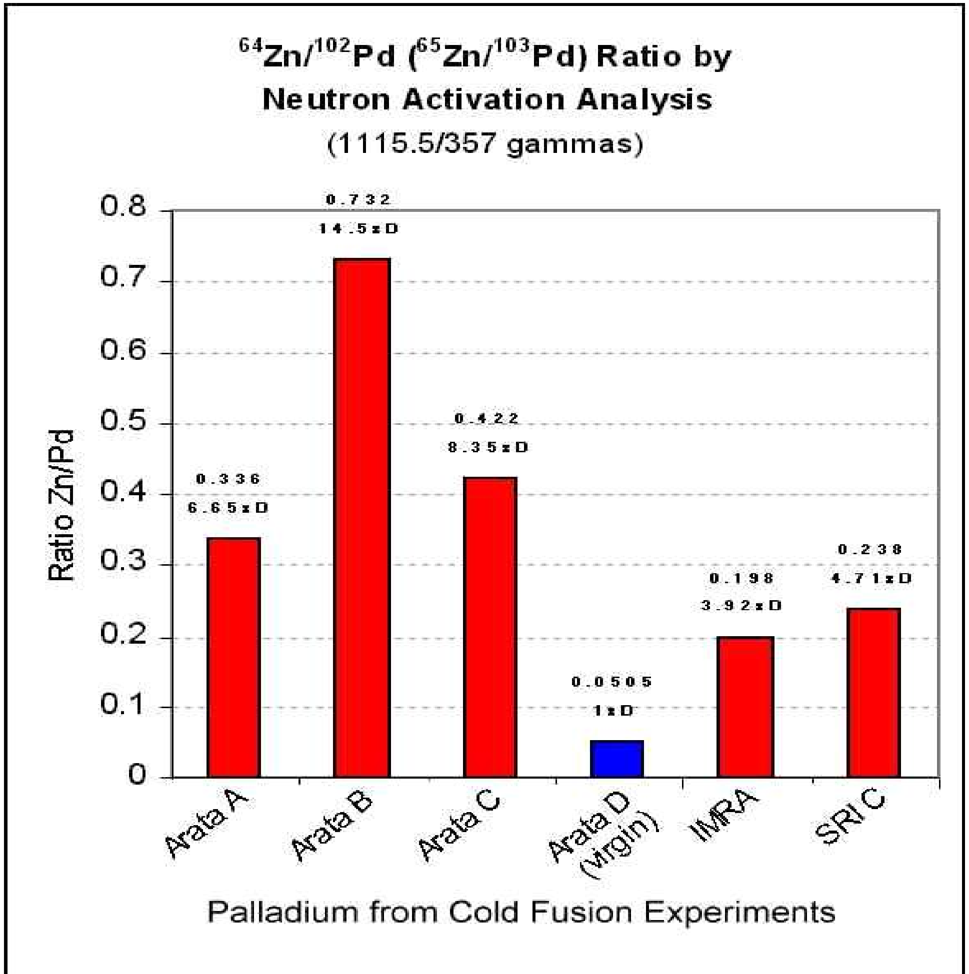
Acknowledgements

- **Many organizations and people have contributed to the work of D2FUSION, these include:**
  - Electric Power Research Institute
  - Stanford Research International
  - Los Alamos National Laboratory
  - Pacific Northwest National Laboratory
  - Rockwell National Laboratory
  - Lockheed Martin Corporation
  - General Atomics Corporation
  - The US Naval Research Laboratory
  - Charles Evans and Associates Research
  - The US Bureau of Mines Helium Laboratory
  - The US National Institute for Electron Microscopy
  - The Boreskov Institute for Catalysis
  - Catalytica Corporation
  - United Catalysts
  - Stanford University
  - Portland State University
  - The University of Osaka
  - Tom Passell, Martin Fleischmann, Jean Paul Biberian, Tom Benson, Roger Stringham, Dave Nagel, Mike McKubre, Fran Tanzella, Brian Oliver, Brian Clarke, Yoshito Arata, David George,

Extra Slides : Neutron Activation Analysis
Search for high Z isotope shifts



Extra Slides: Isotope Shifts in Palladium

TOF Sims Analysis