

Clusters with Picometer

Distance of Deuterons and LENR

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Search for Nuclear Reactive Site

Review of peioe data suggests localized high density regions.

Reflections on prior work

- Attempts to improve Patterson cell bead type electrodes
 - Beautiful sputtered ones performed poorly compared to “poor” quality electroplated coatings
- Why???
- Other evidence for localized reactions
 - Craters, localized Cr 39, spotty x-ray film, profile of transmutation products

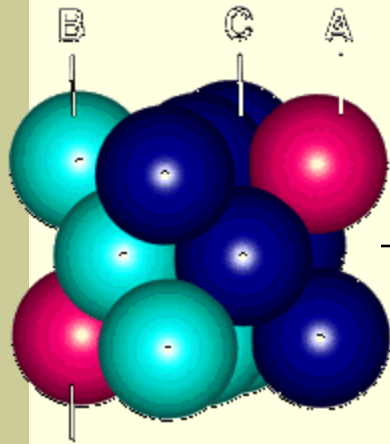
Hypothesis

- The abnormal products from thin films during electrolysis are related to the high density H/D clusters in the dislocation loops form at the multilayer thin film interfaces.

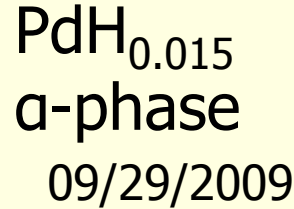
Dislocation-Loop-cluster Studies to verify this hypothesis

- Pd thin foil – 12 μm
- Grow an oxide layer on top of both side foil by heating the foil in butane torch – facilitate deuterium diffusion, prevent dislocation annihilation
- Loading and unloading deuterium/hydrogen was done by cyclically cathodizing and anodizing Pd foil

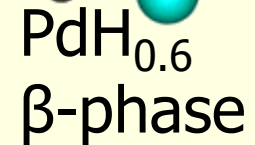
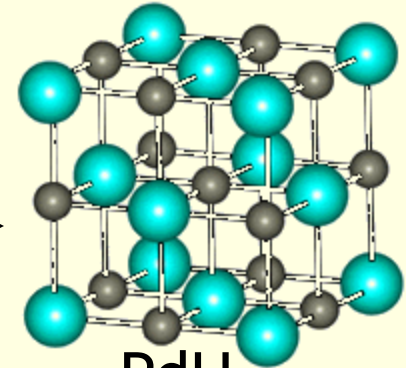
Dislocation Formation 1



H₂
charging



H₂
charging



Palladium lattice

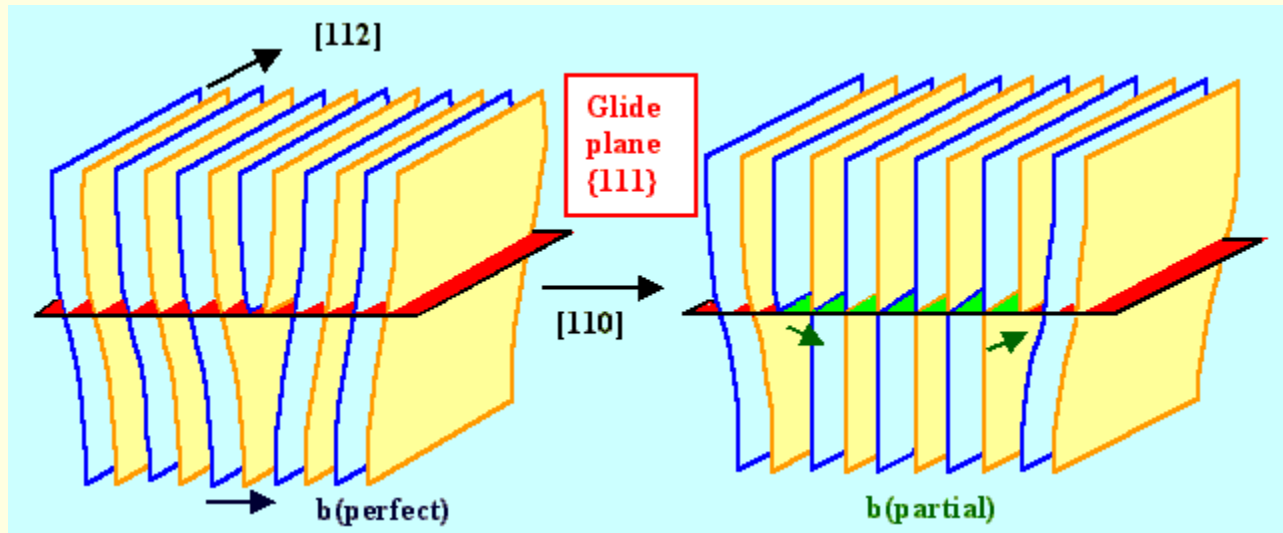
3.889 Å

3.889 Å

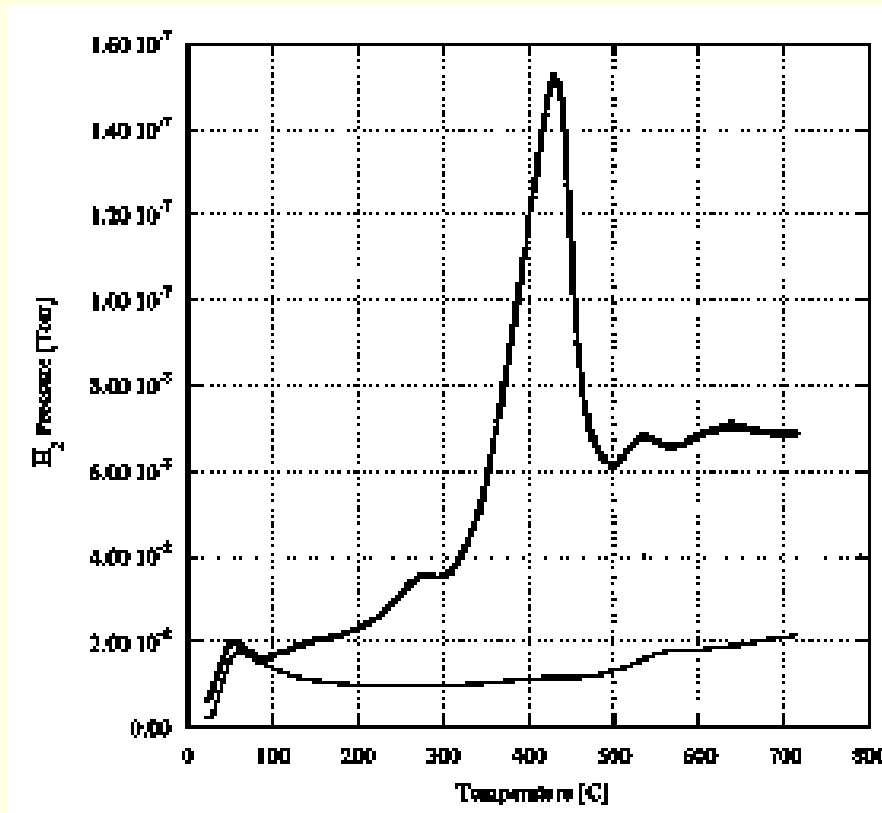
4.025 Å

When the stress is large enough, dislocation cores form at α/β transformation interface with core radius of one burgers factor, 0.275nm.

Dislocation Formation 2



Measurement #1 - Temperature Programmed Desorption



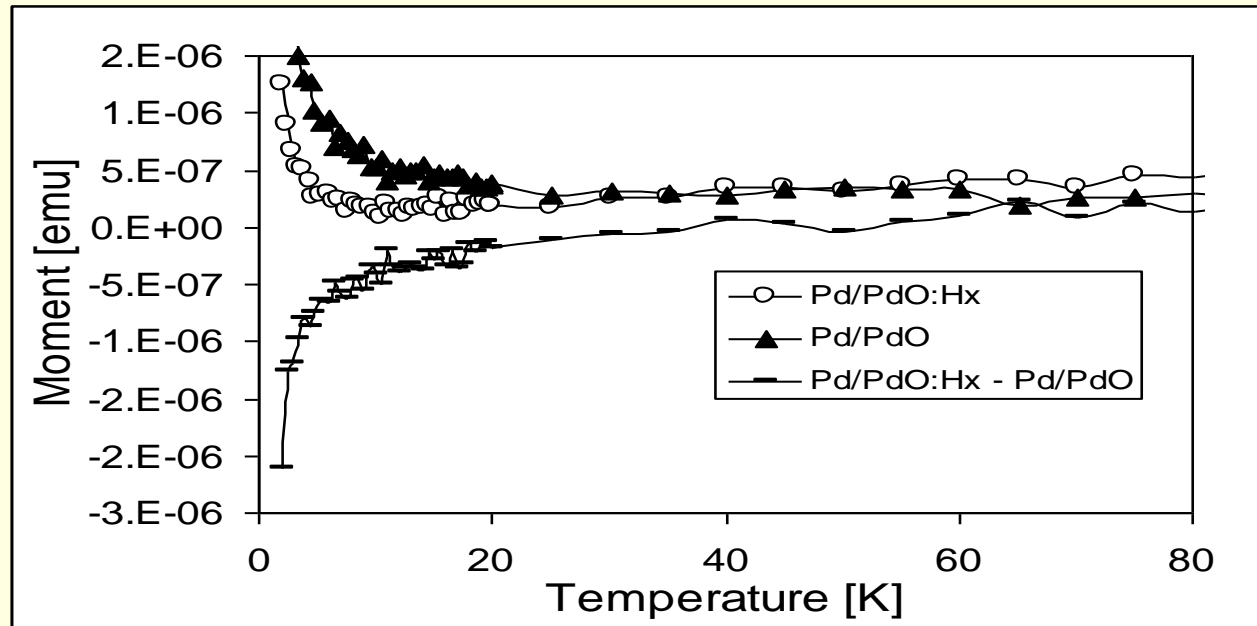
Binding Energy calculation
– close to the binding
energy between hydrogen
and dislocation

$$\varepsilon_H = k_B \frac{T_2 T_1}{(T_2 - T_1)} \ln(P_2 / P_1)$$

$$\text{H/Pd} \sim 1.8$$

After the loading foil was annealed under 300 °C for 2 hr, the temperature was ramped from 20 °C to 800 °C at 9 °C /min.

Measurement #2 - Magnetic Moment Measurements show superconducting state



The magnetic moment of H^2 -cycled PdHx samples in the temperature range of $2 \leq T < 70$ K is significantly lower than $M(T)$ for the original Pd/PdO.

A. Lipson, B.I. Heuser, C. Castano, G.L. Miley, B. Lyakov & A. Mitin, [Physical Review B 72](#), 212507/1-6 (2005):

Conclusion:
superconductivity state < 70
K and D Cluster
condensation at room
temperature

Predictions

LENR cell with high packing fraction ($>10\%$) of cluster forming defects leads to large ($> 500\%$) excess heat.

New quest – large # of cluster sites /cc

- 5 methods under investigation
- Down select based on desorption measurements
- Further down select based on chg pt and excess heat studies// or ICF scans
- Use in proto power cell.

Requirements - classical loading and flux no longer figures of merit.

- Loading equivalent in clusters – $10^{18}/\text{cc}$
- > 100 atoms / cluster
- Proper trigger
 - Pulsed current
 - Pulsed diffusion flux
 - Particle-photon stimulation
 - [compression] = icf target

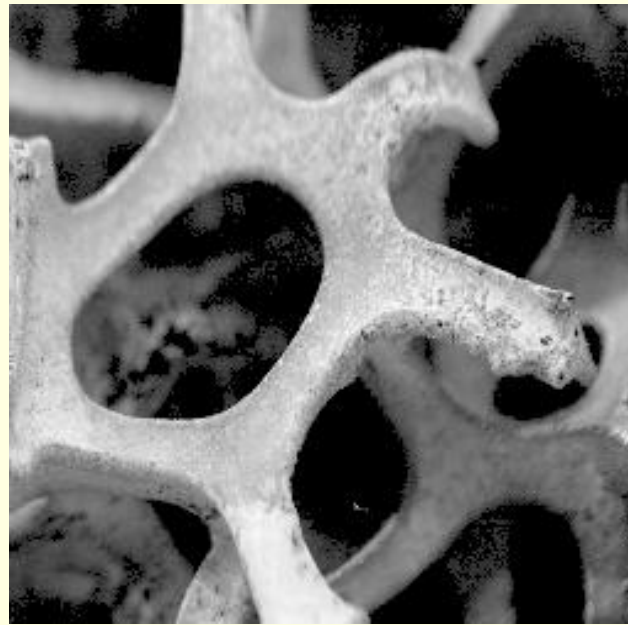
5 types Nano-Structured electrodes under study-- Ex 1

- Objective – mimic dislocation loop structure obtained from cycling, but –
- Increase the density (#/cc) of loops

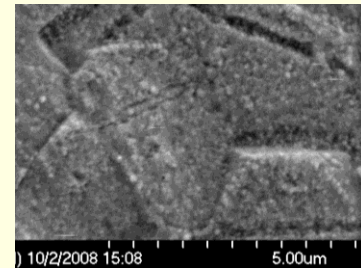
Nano-Structure electrodes



Ni felt



Ni Foam



Zoom-in view
Showing Pd
nanostructures on
the Ni Foam

Ex 2 - Clusters in Rydberg Matter and in Inverted Rydberg Matter

Known from space chemistry: New catalytic generation of deuterium clusters in surface defects of iron oxide. Emission of clusters and laser irradiation confirms binding energy of 620 eV and **distance between deuterons of $d = 2.3$ pm with density of $n_D = 10^{29}$ cm⁻³.**

Rydberg Matter

Atoms where the orbital quantum number $\ell = 1$ or higher

distance of atoms in H₂ molecules is 74 pm, but with $\ell = 1$, distance is 150 pm.

In Universe: these atoms form clusters called H(1) or D(1)

Inverted Rydberg matter

Binding of a deuteron in the field of an electron: state D(-1)

“Bohr”-radius d is reduced

$$d_R/d_{R^*} = (m_D/m_e)^{1/2}$$

Distance = 2.4 pm

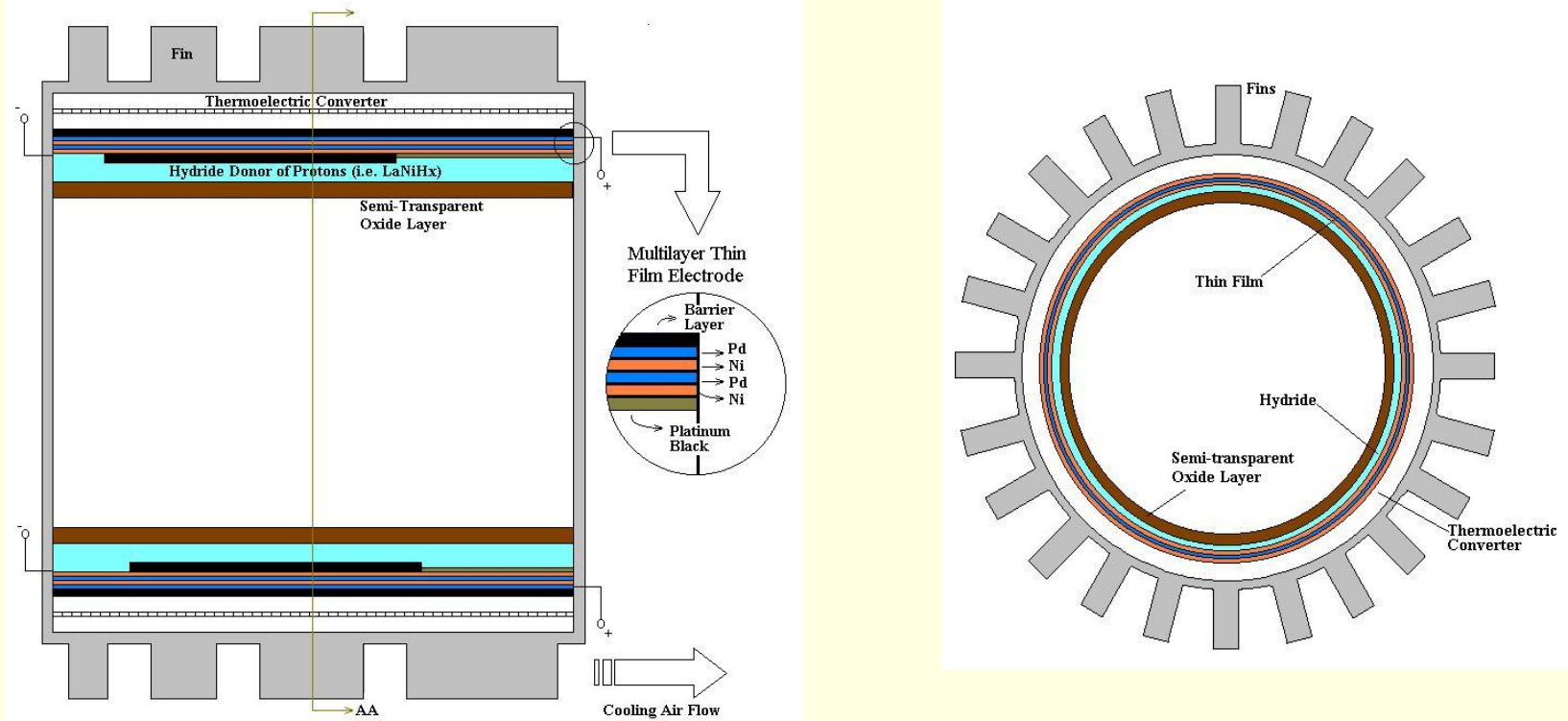
Measured: 2.3 pm

Catalytic Generation of D(1)

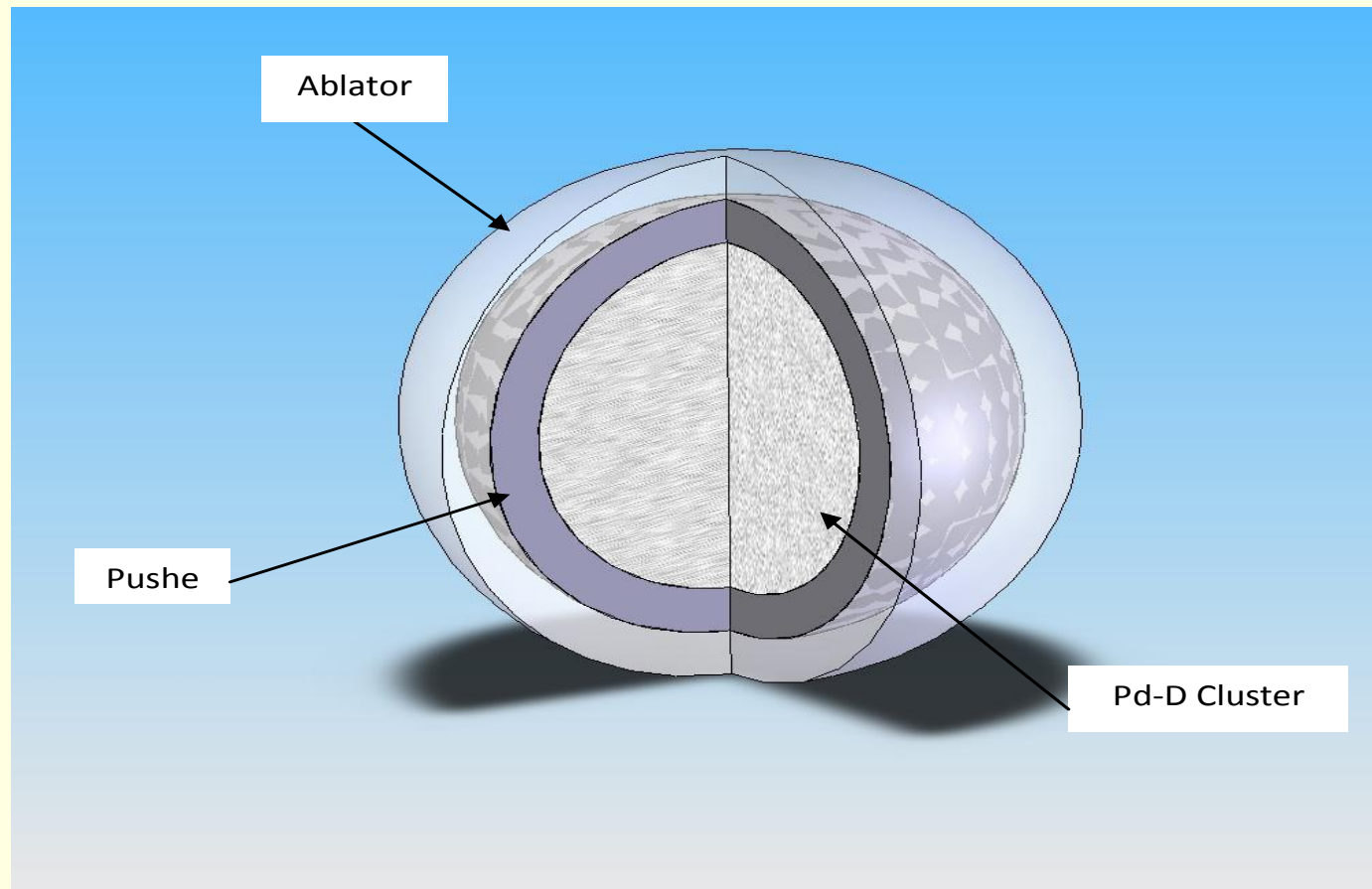
Clusters in defects in iron oxide for low temperature generation

Our recent experiments verified this using a laser to expel the electron and a TOF measurement of ion recoil energy.

Cluster view = road map to high gain cell - Current view of a Hydride Gas-Loaded Thin Film Cluster-type Electrode



Alternate use – non-crogenic ICF targets. Cluster
give ultra high compressed density and fusion
reaction rates



1st exps to test compression scheduled at LANL in fall

Conclusions

- Experimental evidence confirms cluster formation in dislocation loops
- Methods to fabricate high loop density under study
- Conceptually offers a high reaction rate electrode for LENR or for ICF target
- First test – ICF target shots at LANL in fall.
- LENR cell studies to follow down selection process – hopefully late fall.
- Many issues remain –

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