Experimental Evidence for LENR in a Polarized Pd/D Lattice

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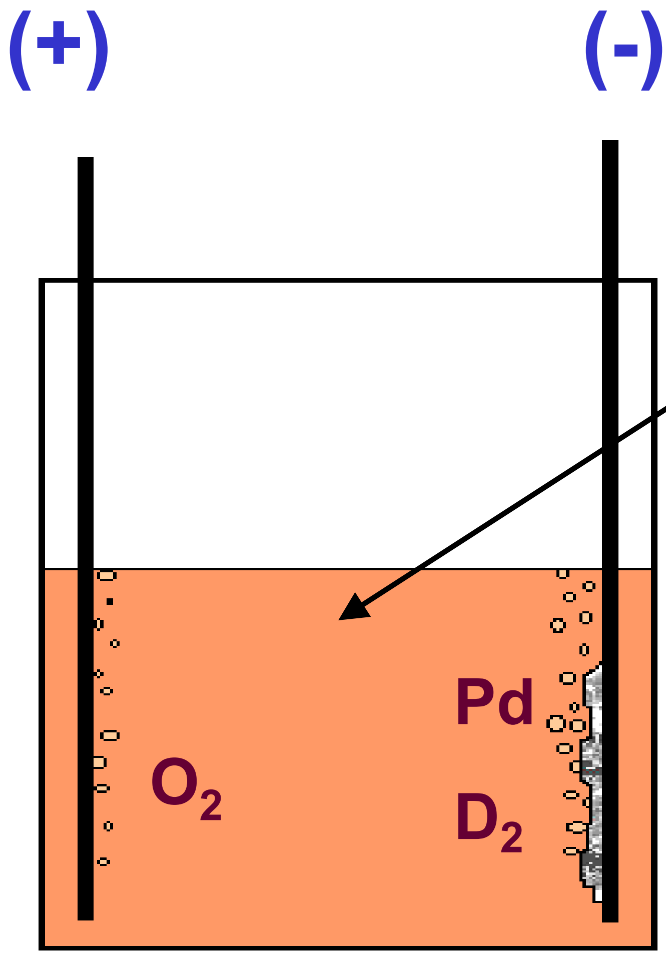
Why Many Laboratories Failed to Reproduce the Fleischmann-Pons Effect

- Improper cell configuration
  - Cathode was not fully immersed in the heavy water
  - Asymmetrical arrangement of anode and cathode
- Unknown history of the palladium cathodes used in the experiments
- Lack of recognition that an incubation time of weeks was necessary to produce the effect

Another Way to Conduct LENR Experiments: Pd/D Co-deposition



$PdCl_2$ and LiCl in a deuterated water solution

As current is applied, Pd is deposited on the cathode. Electrochemical reactions occurring at the cathode:

$$Pd^{2+} + 2\,e^{-} \rightarrow Pd^{0}$$

$$D_2O + e^{-} \rightarrow D^{0} + OD^{-}$$

The result is metallic Pd is deposited in the presence of evolving D_2

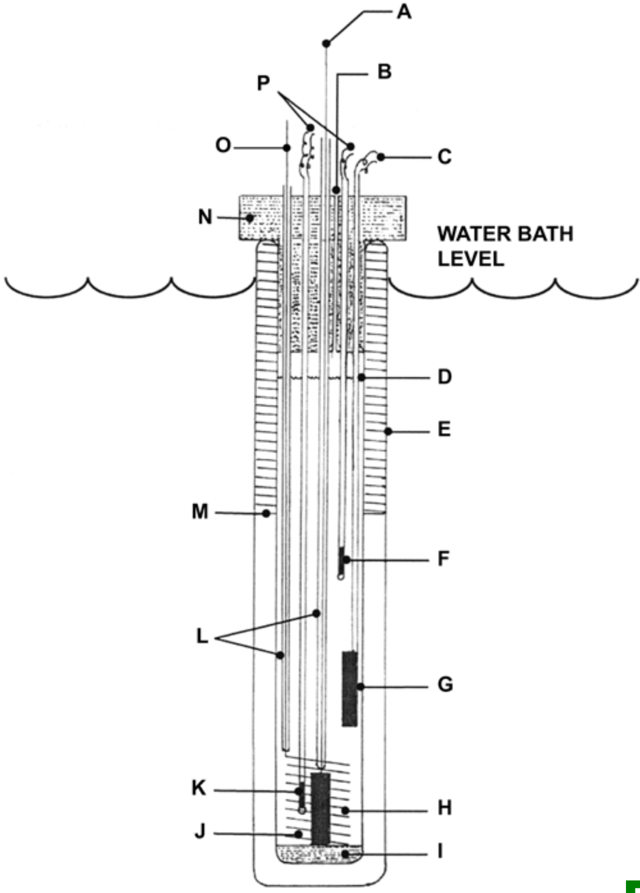
Advantages of Pd/D Co-Deposition

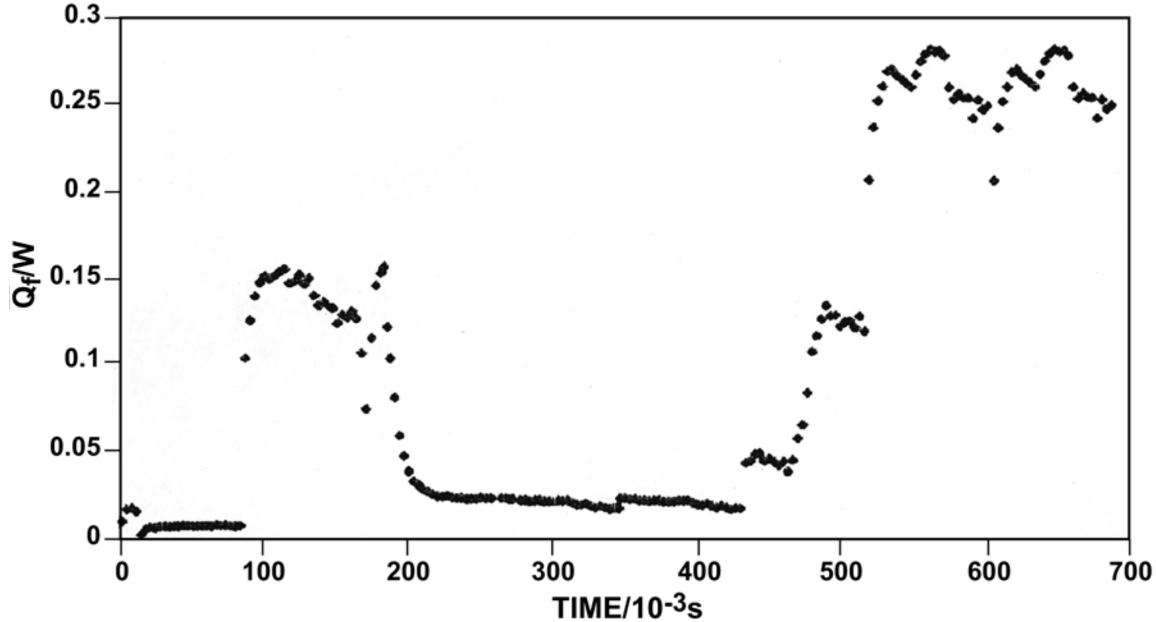
- Short loading times—measurable effects within minutes, no incubation time
  - J. Electroanal. Chem., Vol.337, pp. 147-163 (1992)
  - J. Electroanal. Chem., Vol.379, pp. 121-127 (1994)
  - J. Electroanal. Chem., Vol. 380, pp. 1-6 (1995)
- Extremely high repeatability
- Maximizes experimental controls
- Experimental flexibility
  - Multiple electrode surfaces possible
  - Multiple electrode geometries possible
  - Multiple cell configurations possible

Our approach was to (1) to understand the process and (2) to look for signatures attributable to nuclear events

Excess Enthalpy Generation

Thermochimica Acta, Vol. 410, pp. 101-107 (2004)

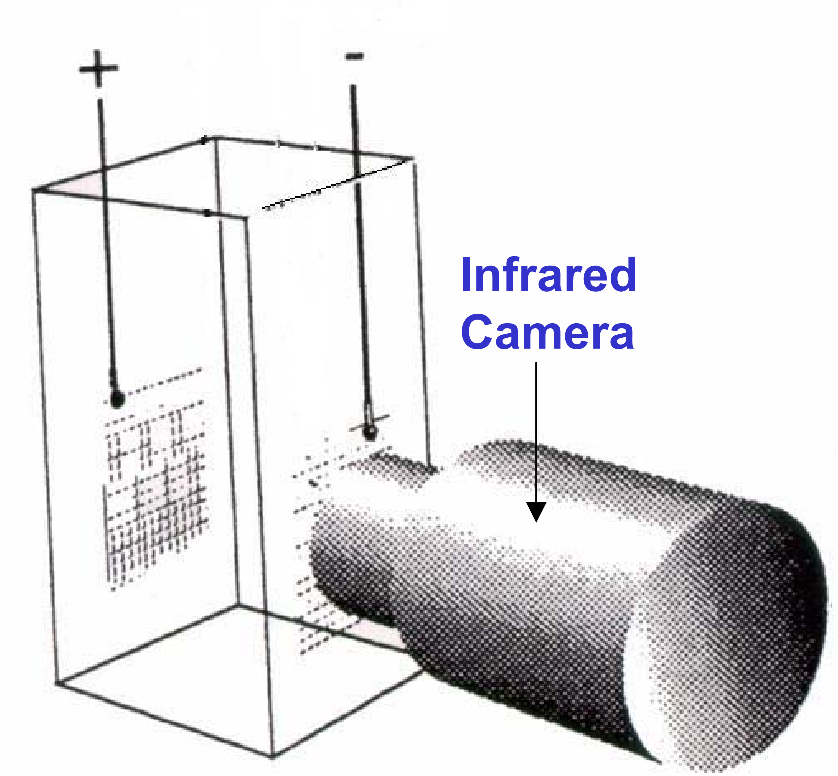


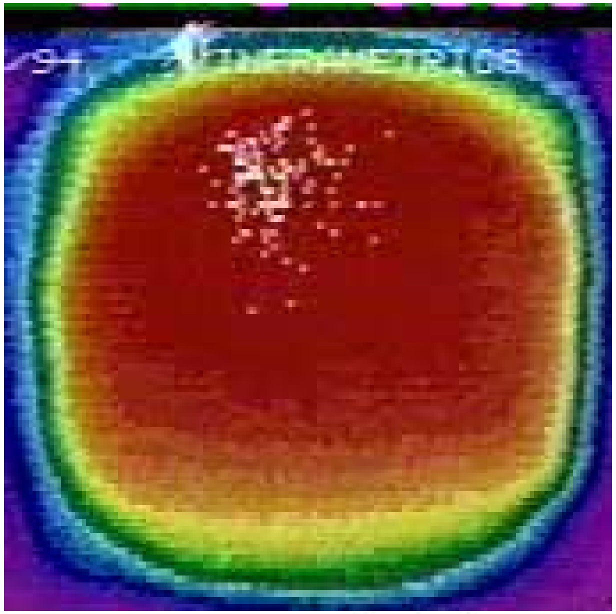


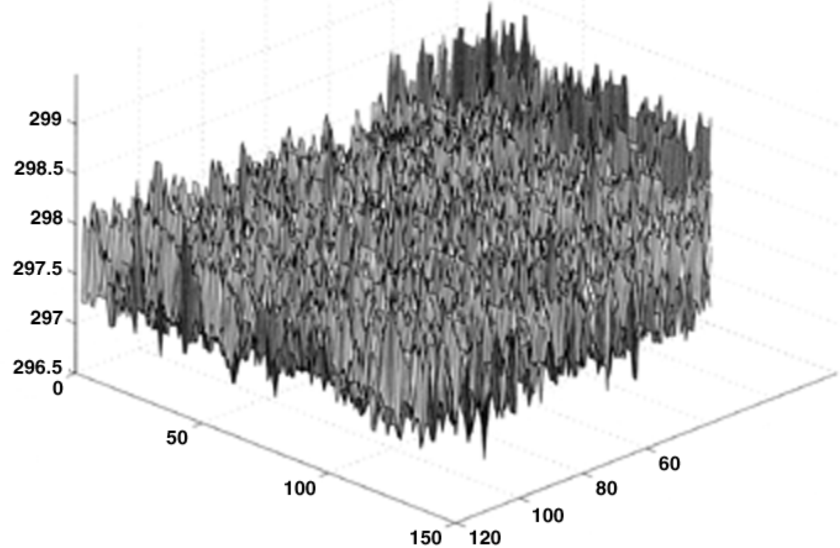
Pd/D co-deposition yields 40% more heat than conventional bulk Pd cathodes

Formation of ‘Hot Spots’

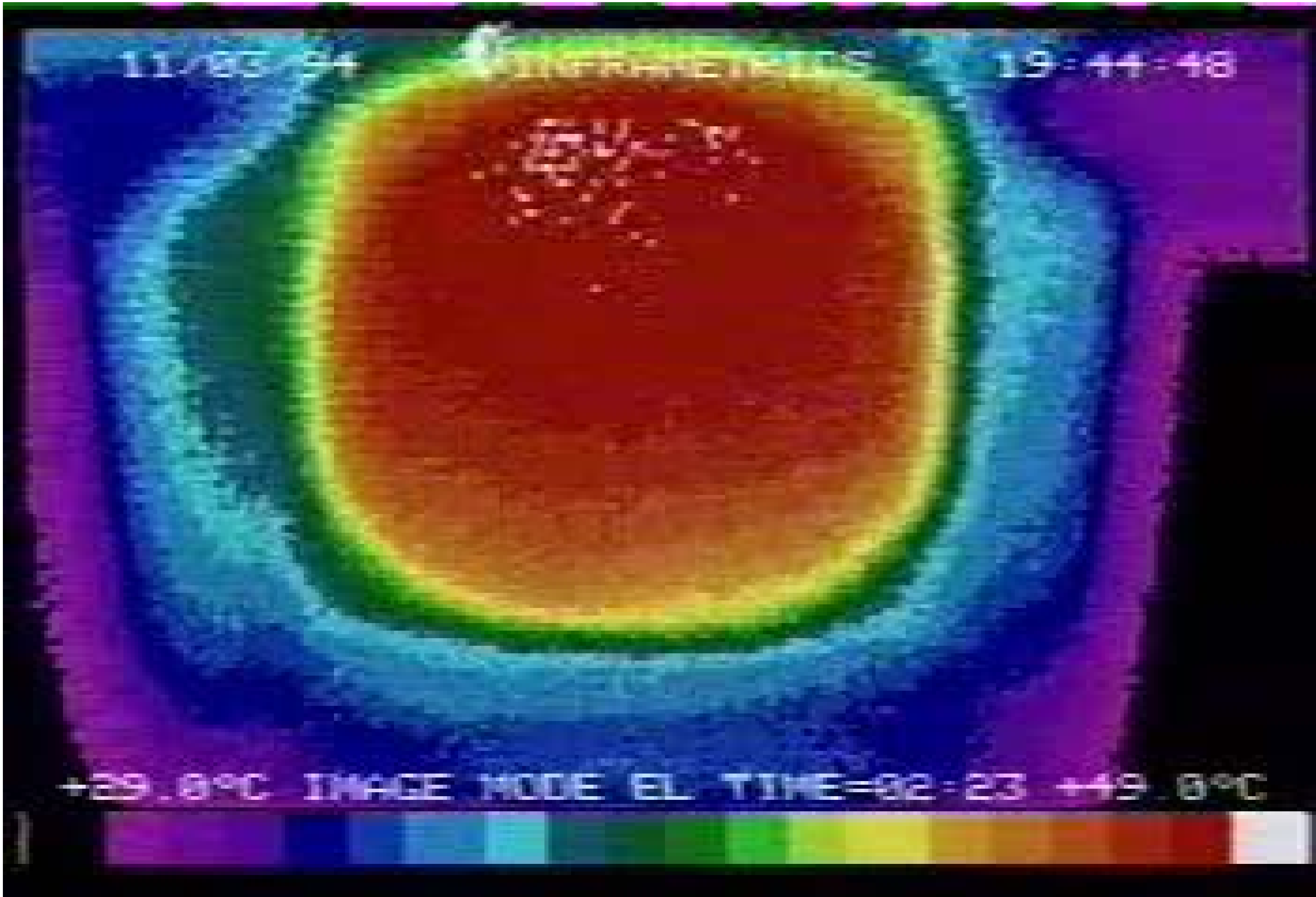
Il Nuovo Cimento. Vol 112A, pp. 577-585 (1999)





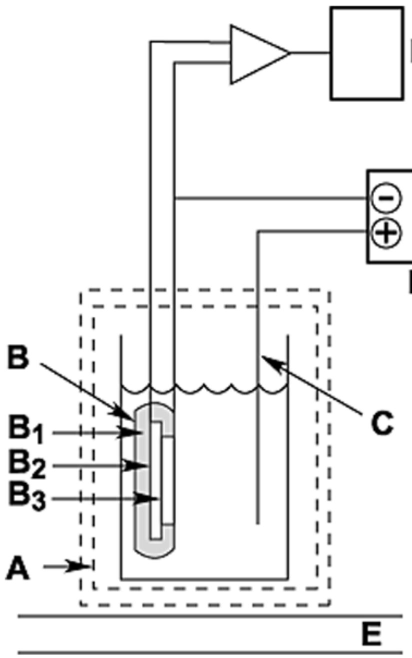


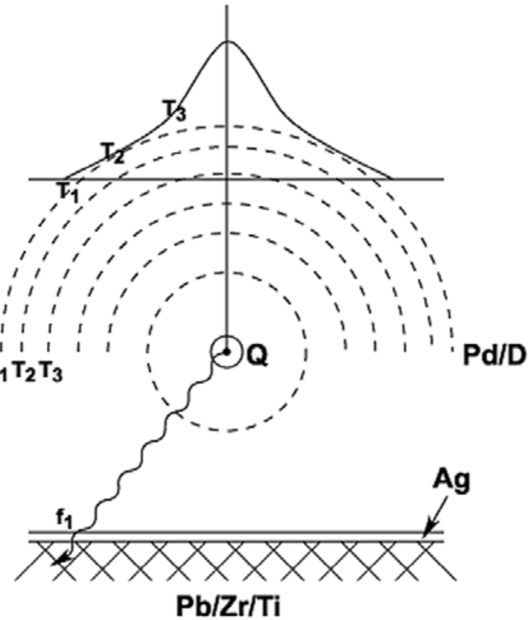
- View perpendicular to the electrode surface showing the distribution of hot spots. View parallel to the surface showing temperature gradients.
- Shows that the cathode is the heat source and not Joule heating.



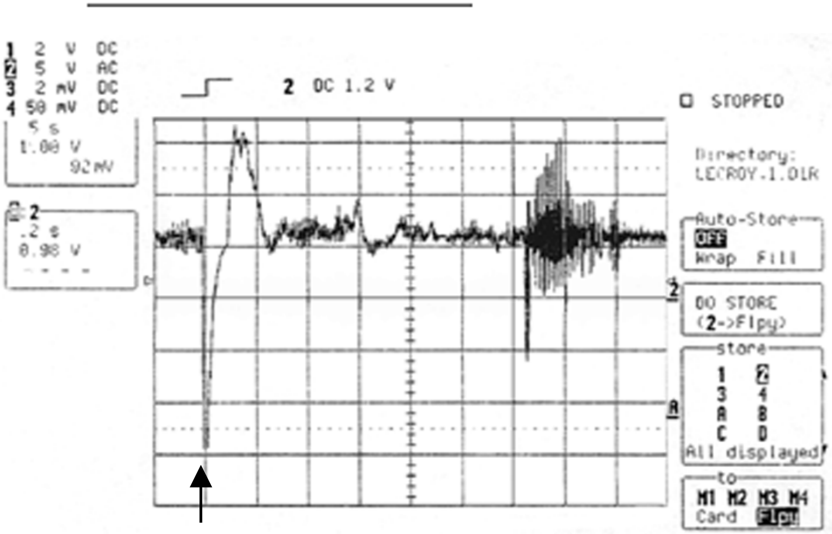
19:44:48
+29.0°C IMAGE MODE EL TIME=02:23 +49.0°C

Piezoelectric Response: Evidence of Mini-Explosions and Heat Generation

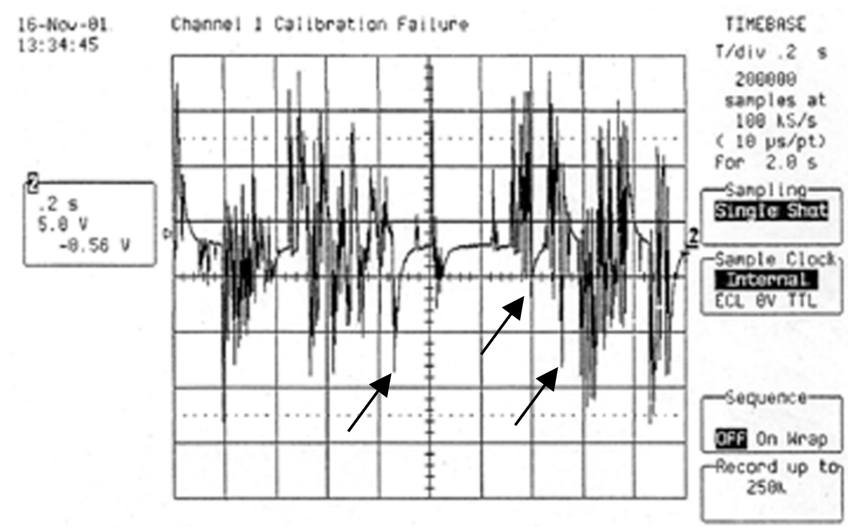




Piezoelectric crystal responds to both pressure and temperature



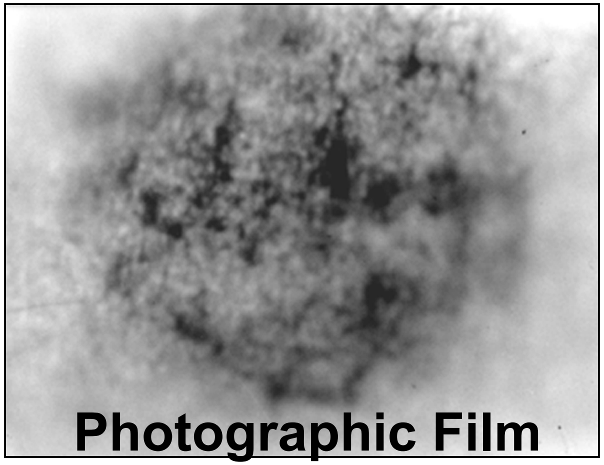
Isolated event

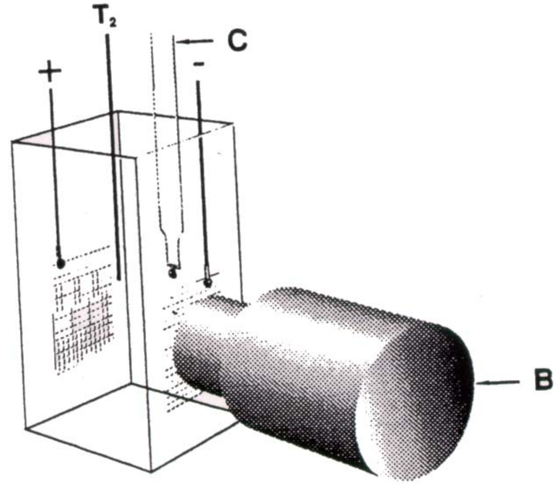


Expanded series of events

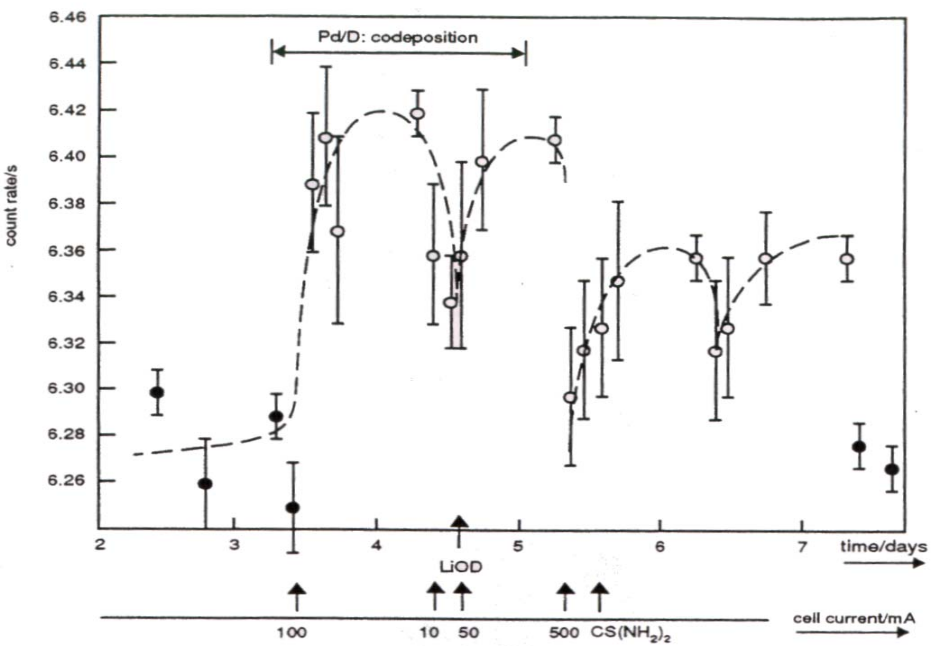
Emission of Low Intensity Radiation

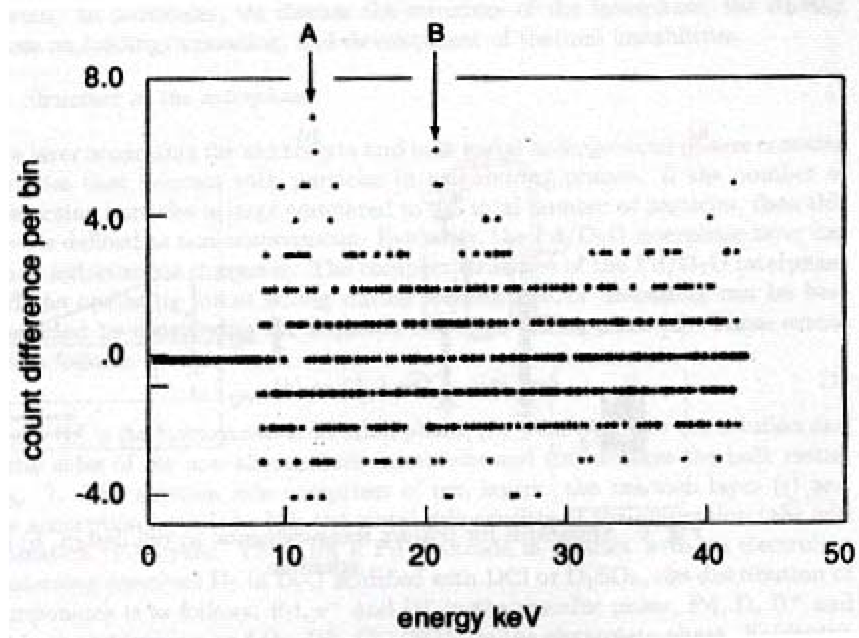
Physics Letters A, Vol. 210, pp. 382-390 (1996)





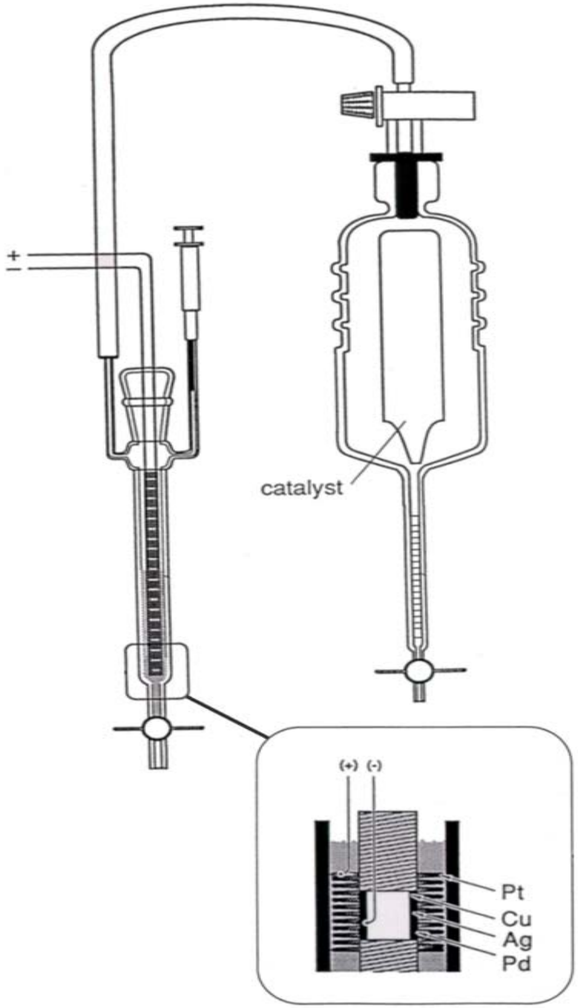
- **X-rays with a broad energy distribution are emitted (with the occassional emergence of recognizable peaks (20 keV due to Pd Kα and 8-12 keV due to either Ni or Pt)**
- **Emission of radiation is sporadic and of limited duration**

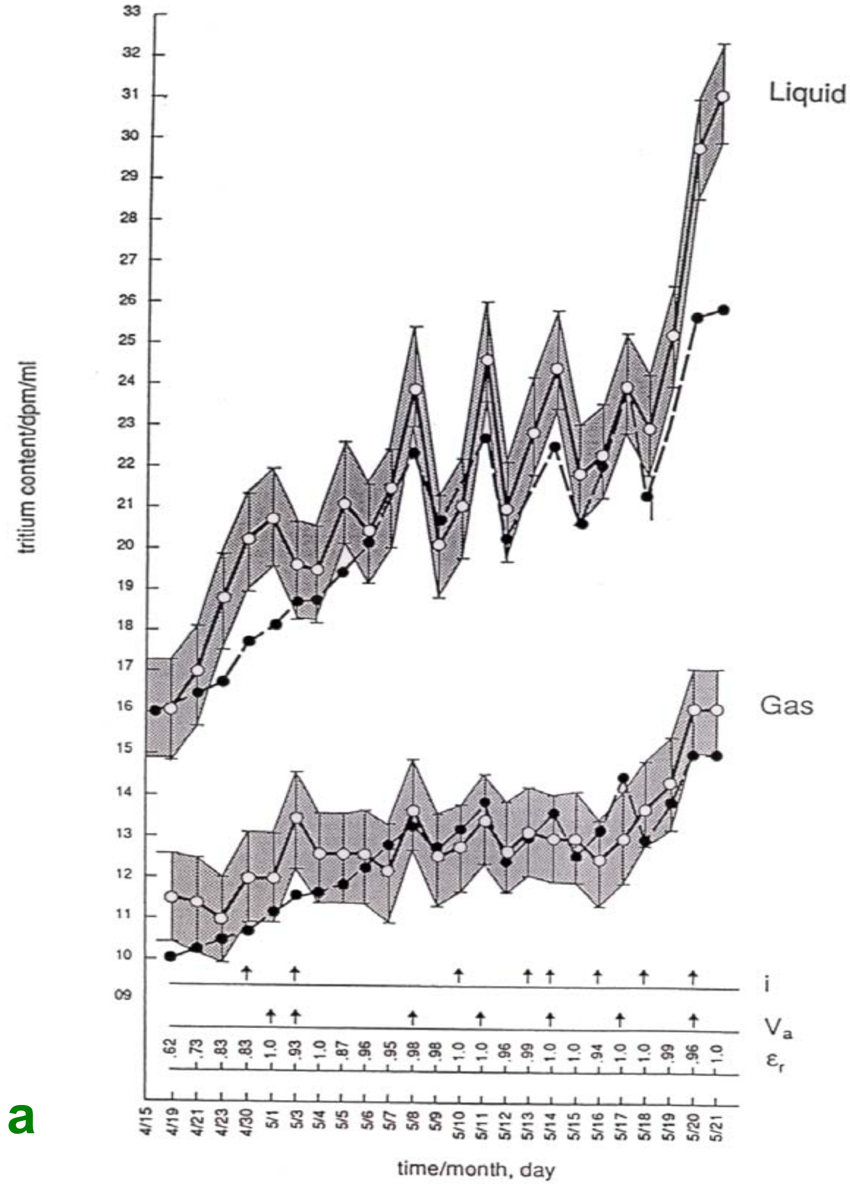




Tritium Production

Fusion Technology, Vol. 33, pp.38-51 (1998)



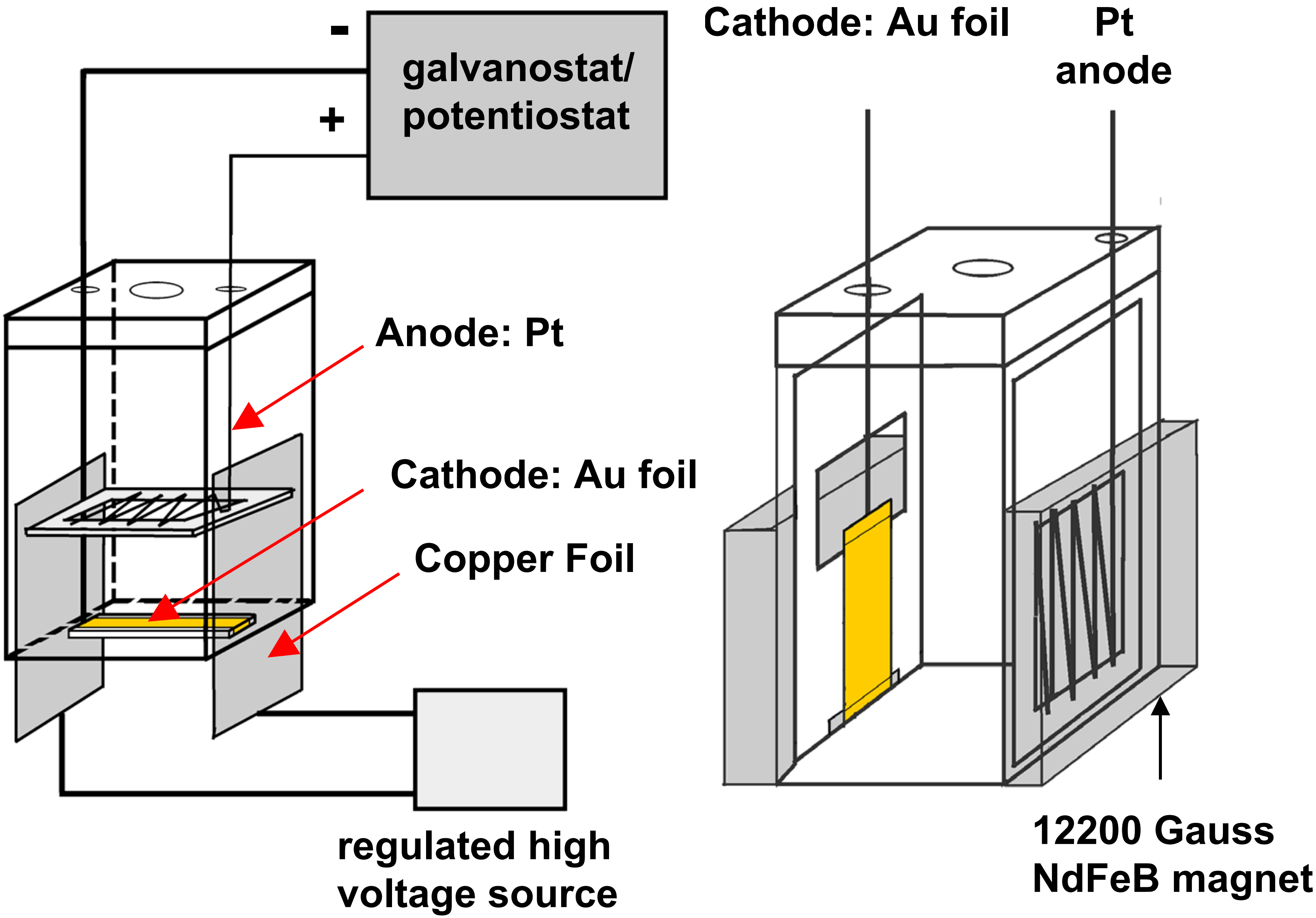


rate of tritium production ranged between 3000-7000 atoms sec^{-1} for a 24 hr period

Overview of Earlier Efforts

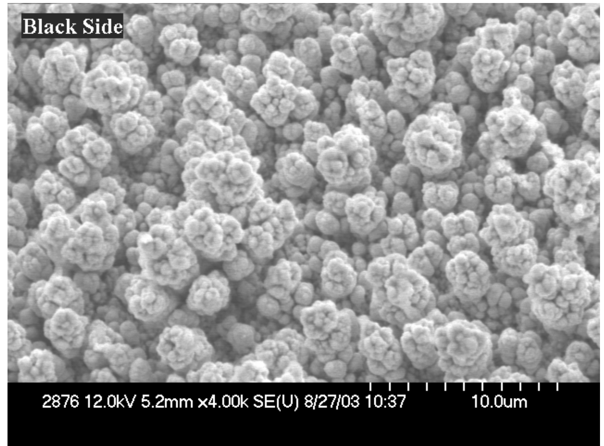
- At this point we know the following:
  - Heat generation, radiation emission, and tritium production are sporadic and occur in bursts. Implies that the sources are discrete/domains
  - Reactions are subsurface (including several atomic layers)
  - There is a relationship between surface state and the bulk
- QUESTION: Can the surface effects be made more pronounced?
- ANSWER: Application of external electric and/or magnetic fields via the Gauss theorem

External Electric and/or Magnetic Field Experimental Configuration



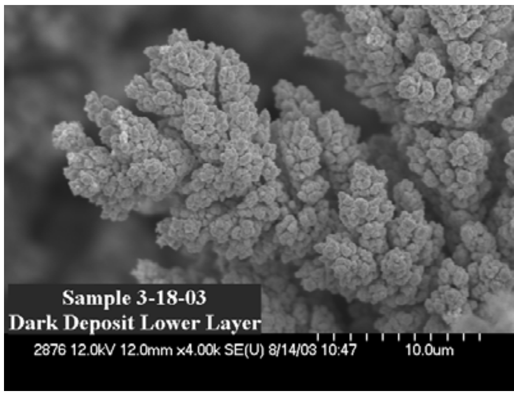
E-Field Morphology Changes – Minor Deformations

J. Electroanal. Chem., Vol. 580, pp. 284-290 (2005)

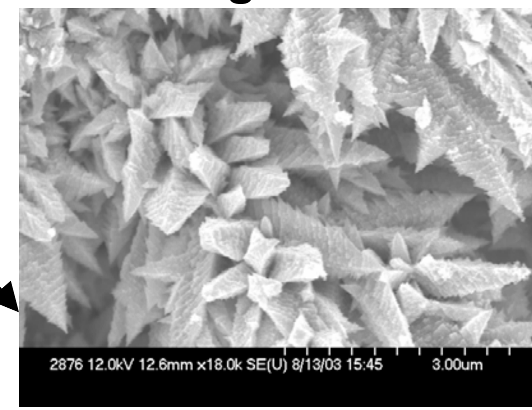


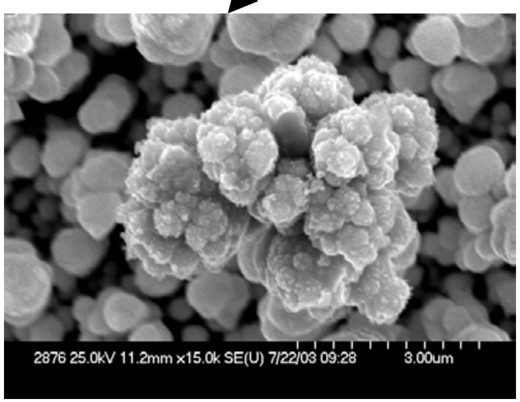
absence of field: cauliflower-like morphology

reorientation of globules without change in size

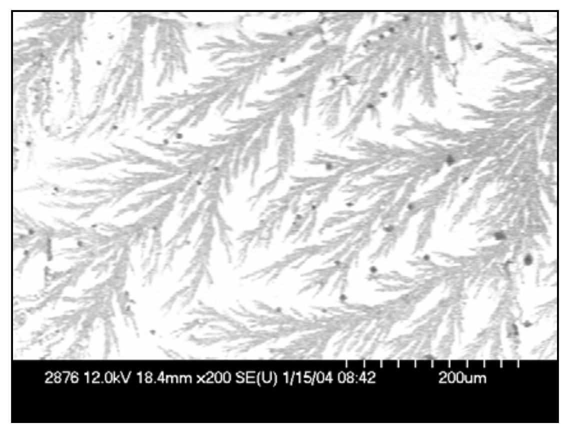


production of dendritic growth



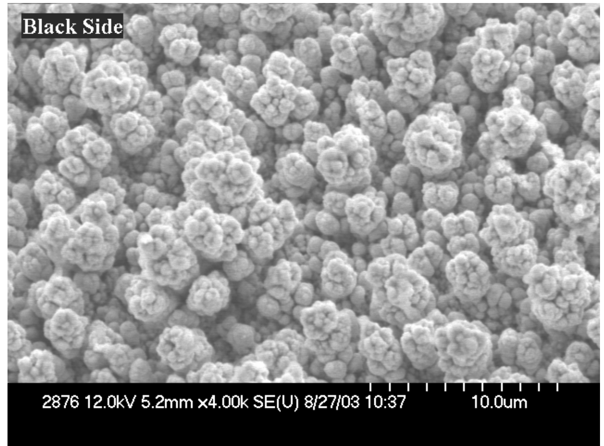


separation of weakly connected globules



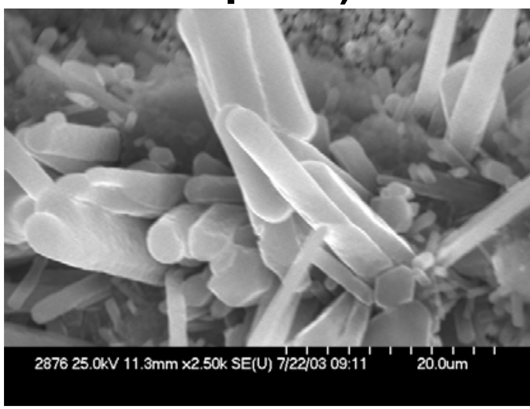
formation of fractals

E-Field Morphology Changes – Reshaping of the Spherical Globules

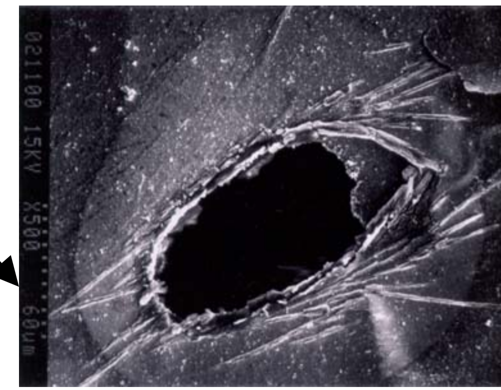


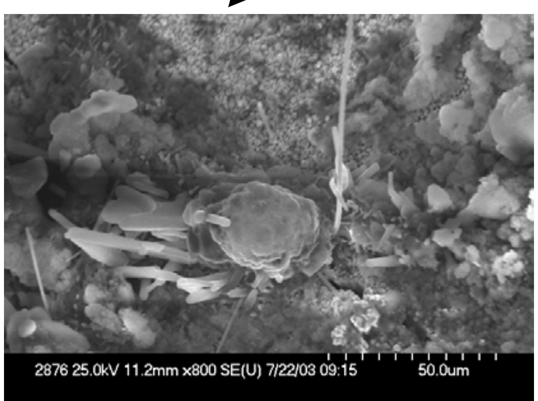
absence of field: cauliflower-like morphology

rods (circular and square)

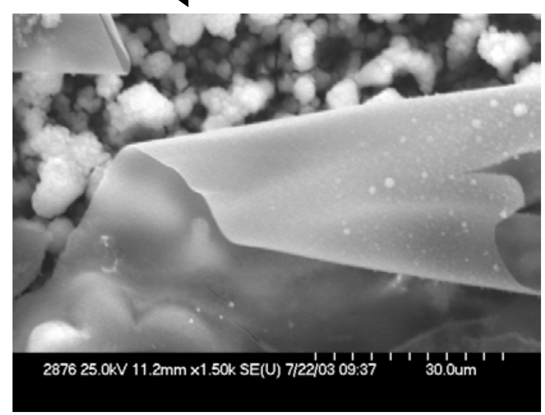


craters





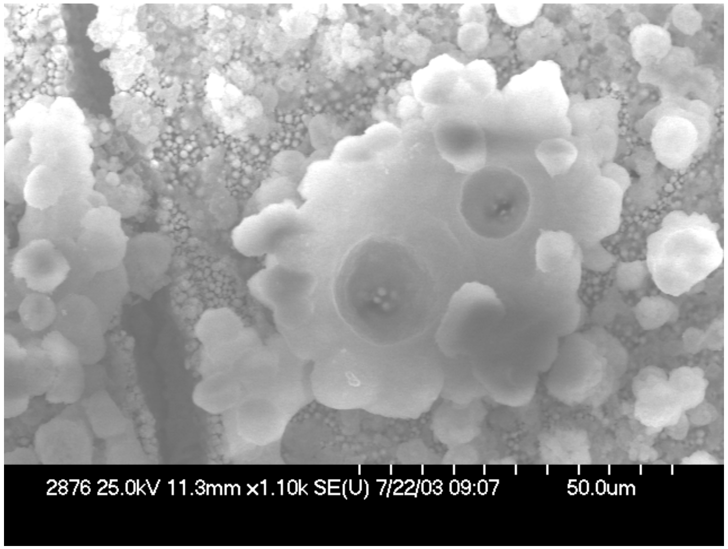
long wires



folded thin films

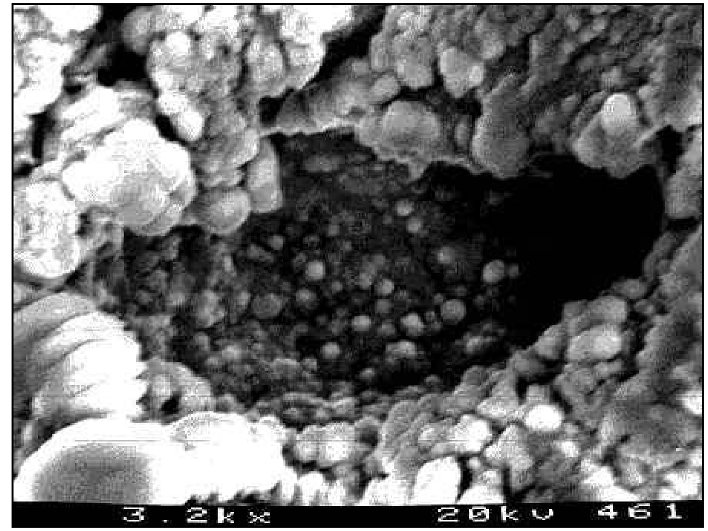
E-Field: Micro-Volcano-Like Features

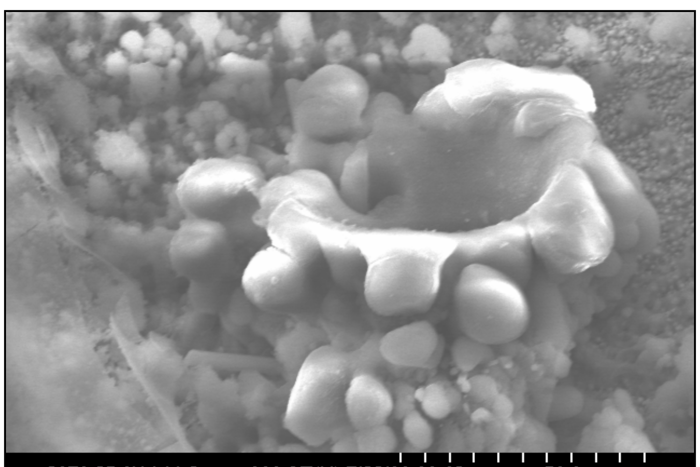
formed in an applied electric field



‘Sonofusion’ of Thin Pd Foils

Roger Stringham 1996

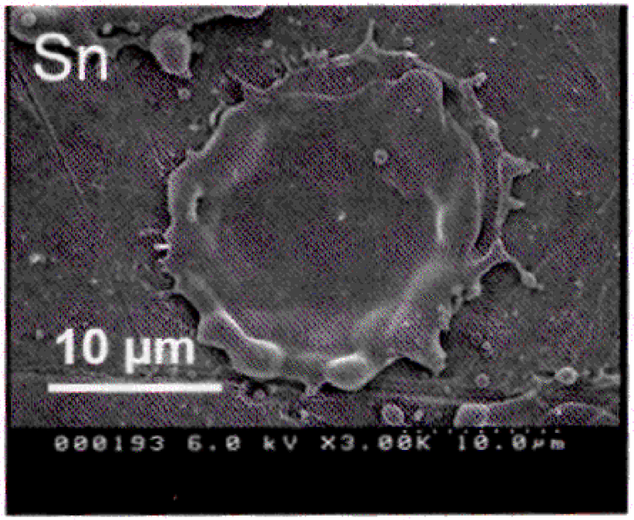


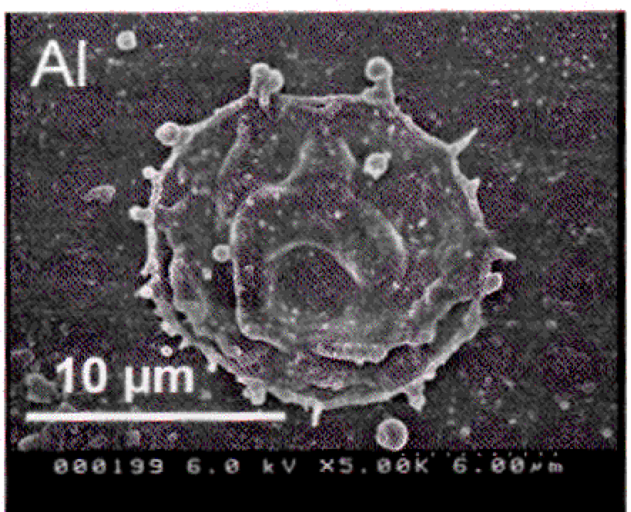


Consultation with experts in nuclear materials nuclear fuels has resulted in a report of previously observed very similar metal damage. This precise kind of damage to metals is consistent with damage seen in materials such as Californium which undergo spontaneous nuclear fission. Indeed such volcano like eruptions have been characterized as resulting from large numbers of spontaneous fissions resulting in "spike damage."

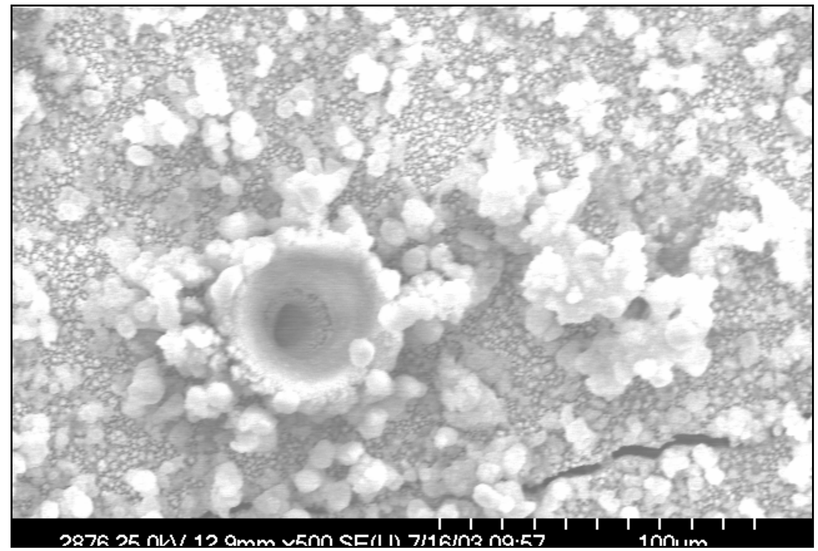
Comparison With Features Observed in Laser Induced Breakdown Spectroscopy (LIBS)

LIBS



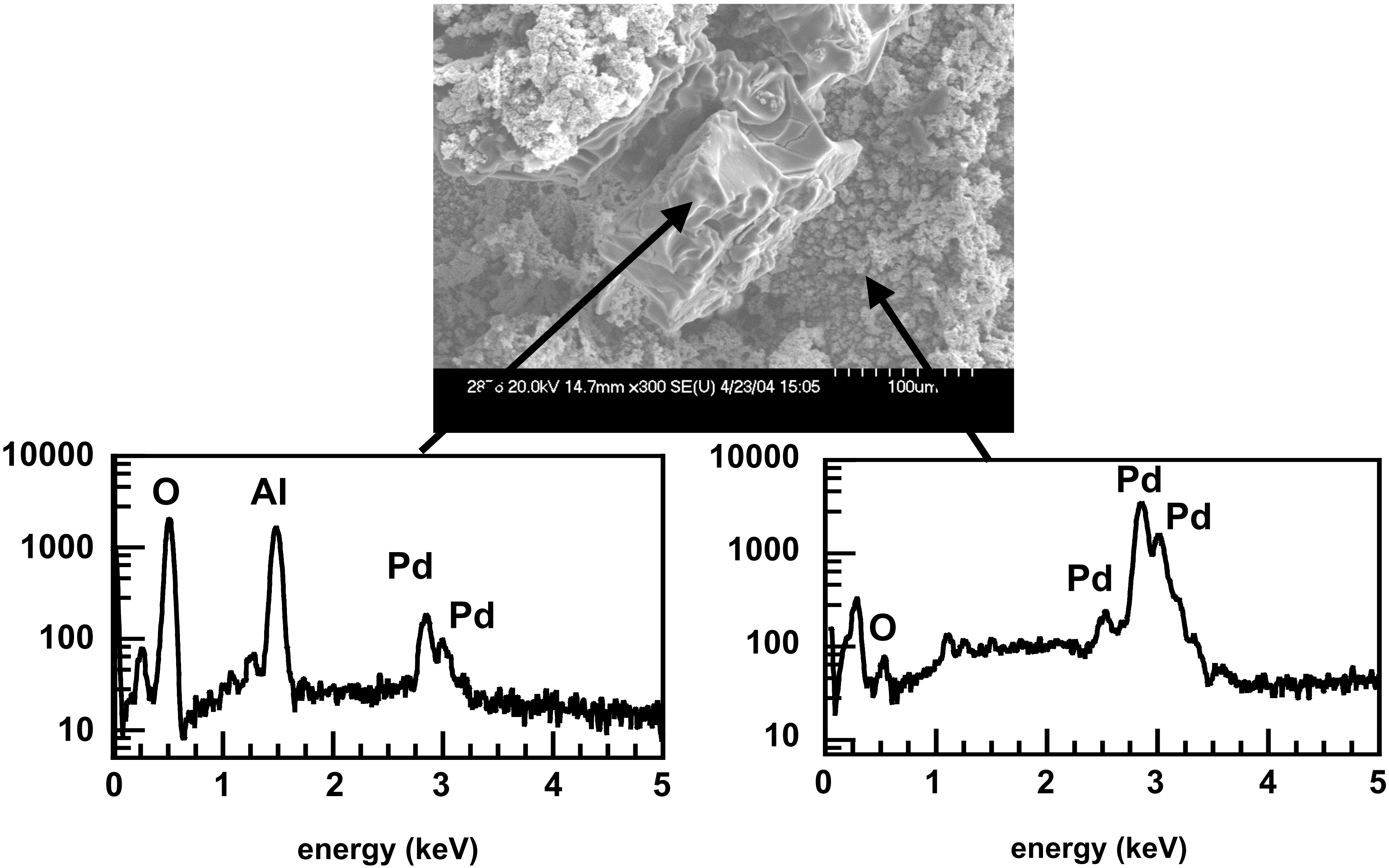


formed in an applied electric field

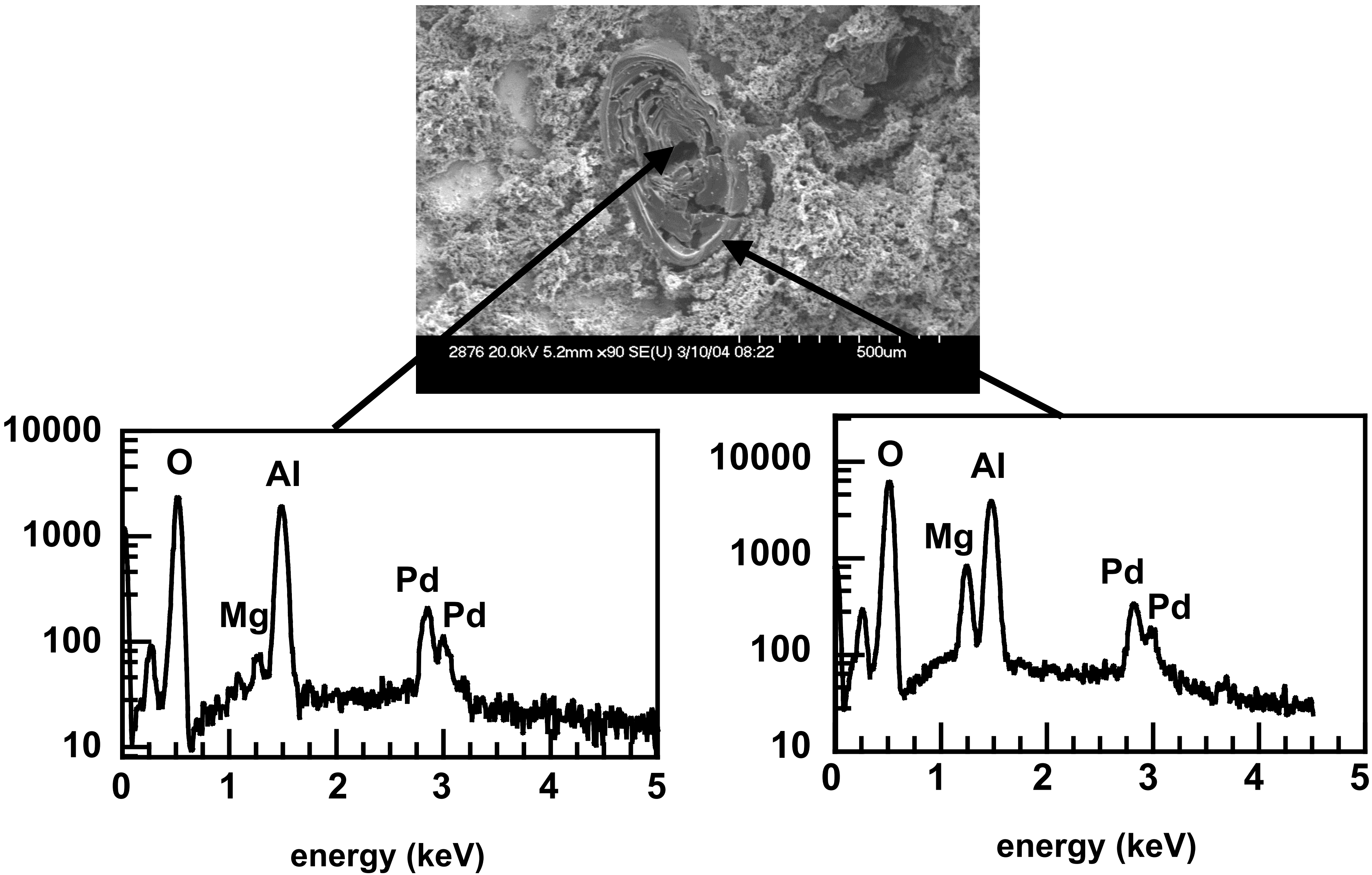


- **Features suggestive of solidification of molten metal.**
- **Energy needed to melt metal is of a nuclear origin.**
  - **Should be reflected by chemical analysis of these features**

Chemical Composition of a 'Boulder-like' Deformation and the Area Adjacent

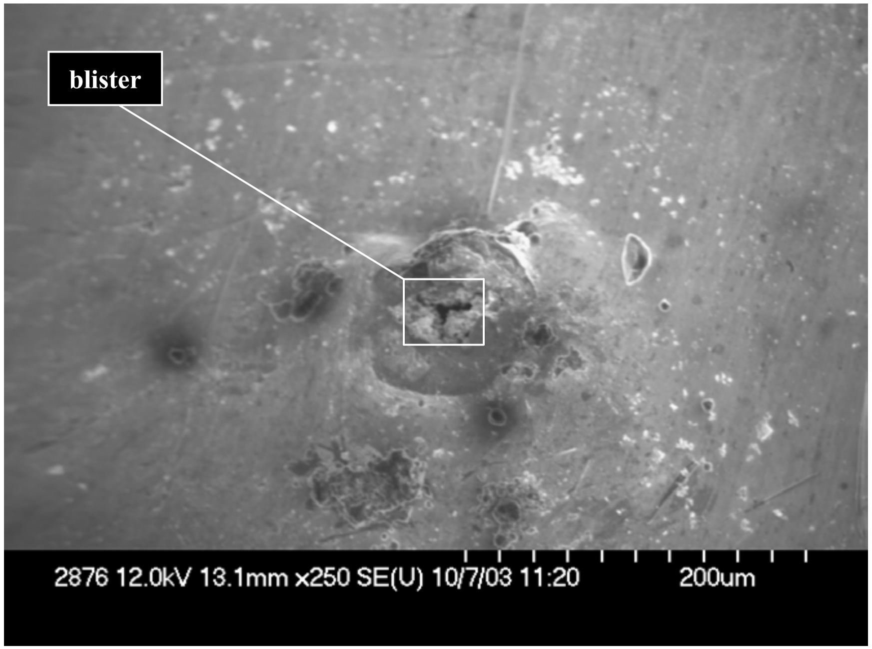


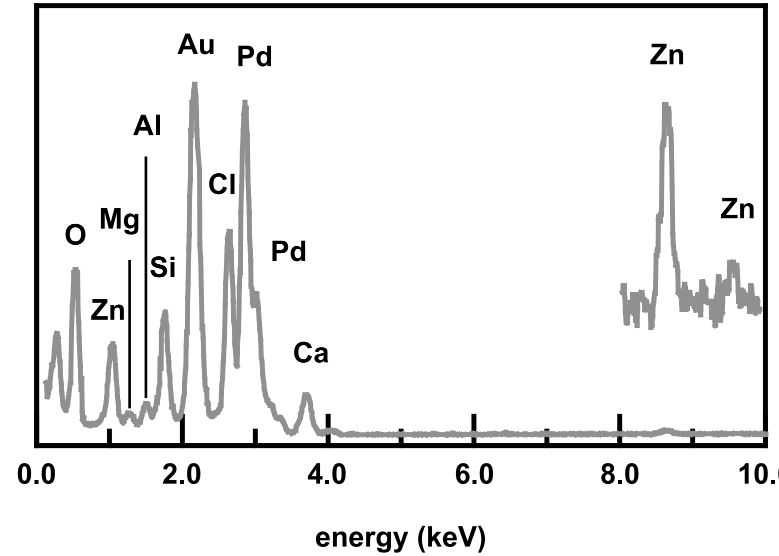
Chemical Composition of the Inside and Outside Rims of a Crater



Chemical Composition of a Detached Thin Film ('Blister') Formed in an Applied Electric Field

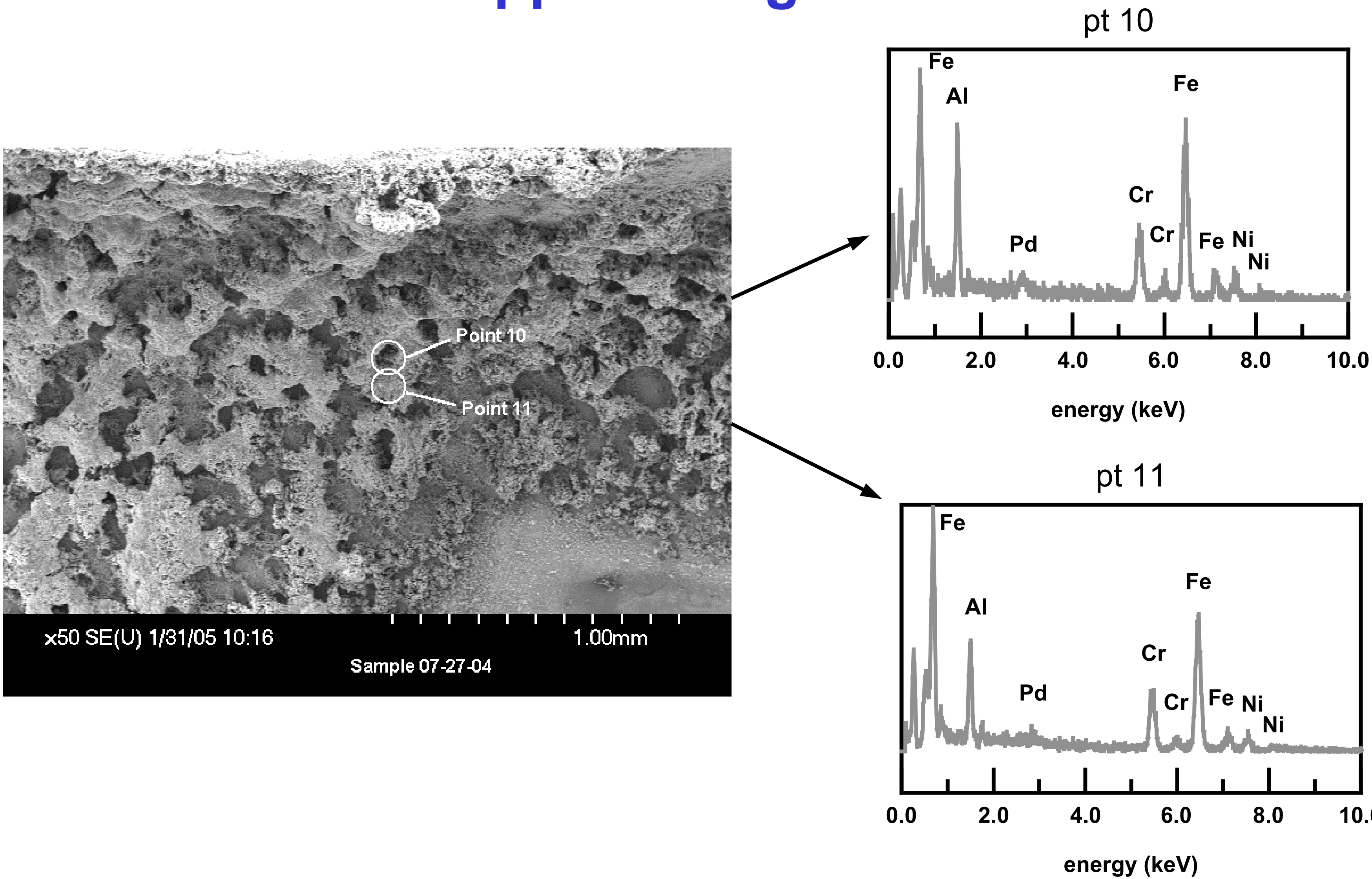
Naturwissenshaften, Vol. 92, pp. 394-397 (2005)





- Analysis of the 'blister' shows the presence of Ca, Al, Si, Mg, Zn, Au, O, and Cl.
  - Au, O, and Cl are present in cell components and cannot be attributed to nuclear events.
- Distribution of Ca, Al, Si, Mg, and Zn is not uniform suggesting that their presence is not the result of contamination.
- Ca, Al, Mg, and Si cannot be electrochemically plated from aqueous solutions

Chemical Composition of Structures Formed in an Applied Magnetic Field



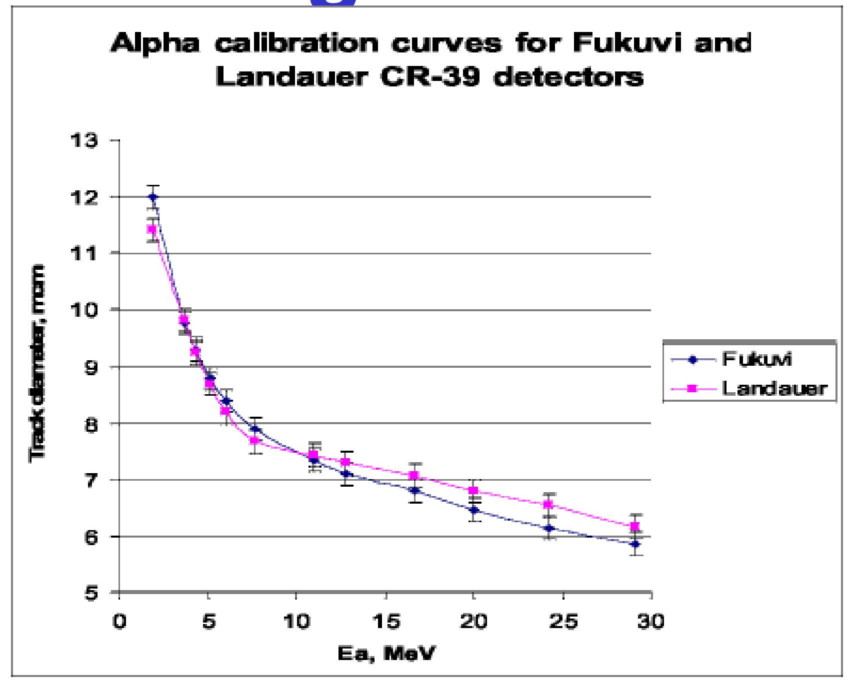
How Can We Verify that the Observed New Elements are Nuclear in Origin?

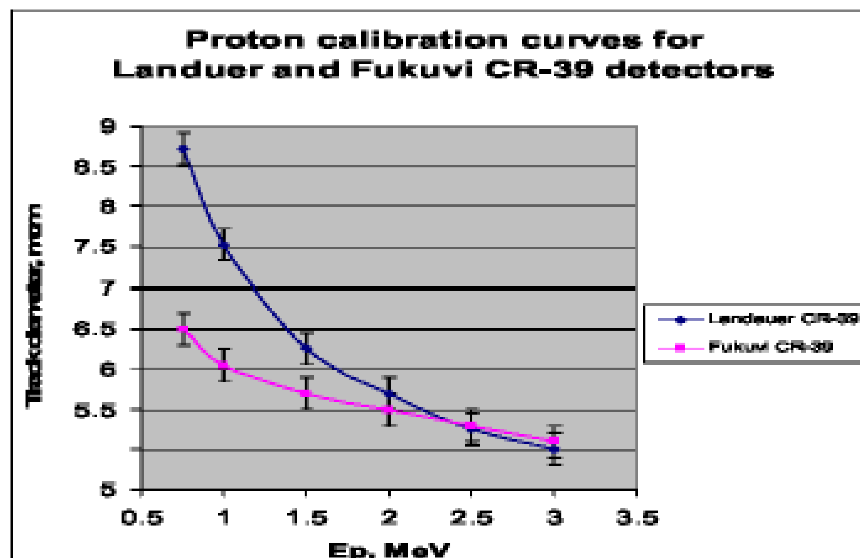
- **SEM-SIMS: look for changes in the isotopic ratios**
- **Measure γ and X-ray emissions**
- **<u>Detect particle emission using CR-39 chips</u>**
  - **Easy to do**
  - **Inexpensive**
  - **Requires minimal instrumentation**
  - **Is a 'constant integration' method**
  - **No electronics**

Particle Detection Using CR-39

- CR-39, polyallyldiglycol carbonate polymer, is widely used as a solid state nuclear track detector
- When traversing a plastic material, charged particles create along their ionization track a region that is more sensitive to chemical etching than the rest of the bulk. After treatment with an etching agent, tracks remain as holes or pits and their size and shape can be measured.

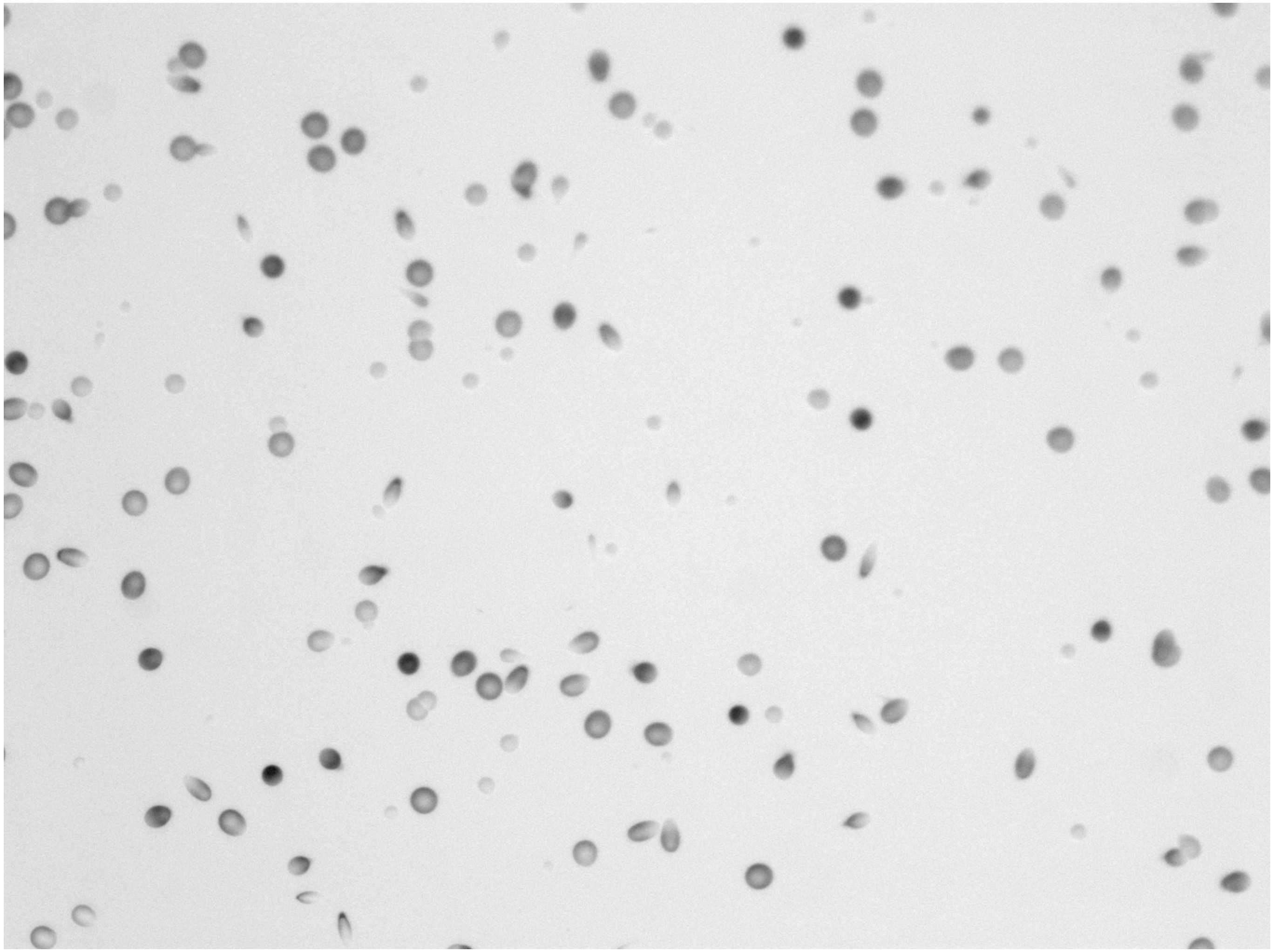
Calibration curves obtained by A.G. Lipson, A.S. Roussetski, G.H. Miley, E.I. Saunin, ICCF10



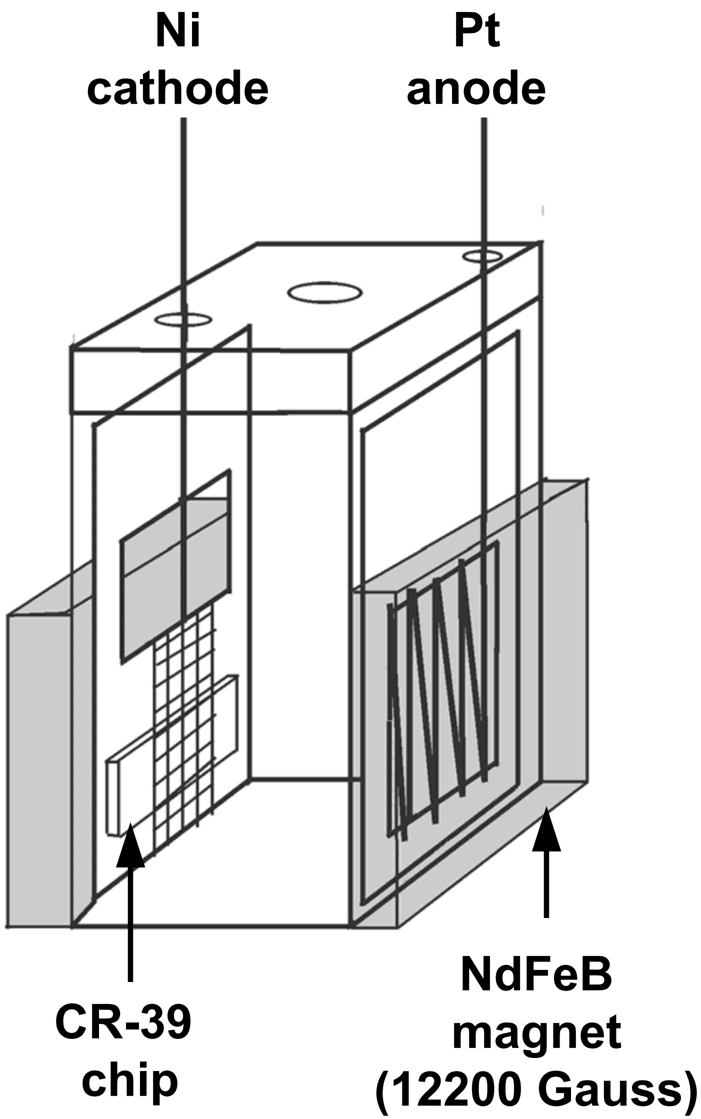


CR-39: Evidence of Particle Emission from Depleted Uranium

200X



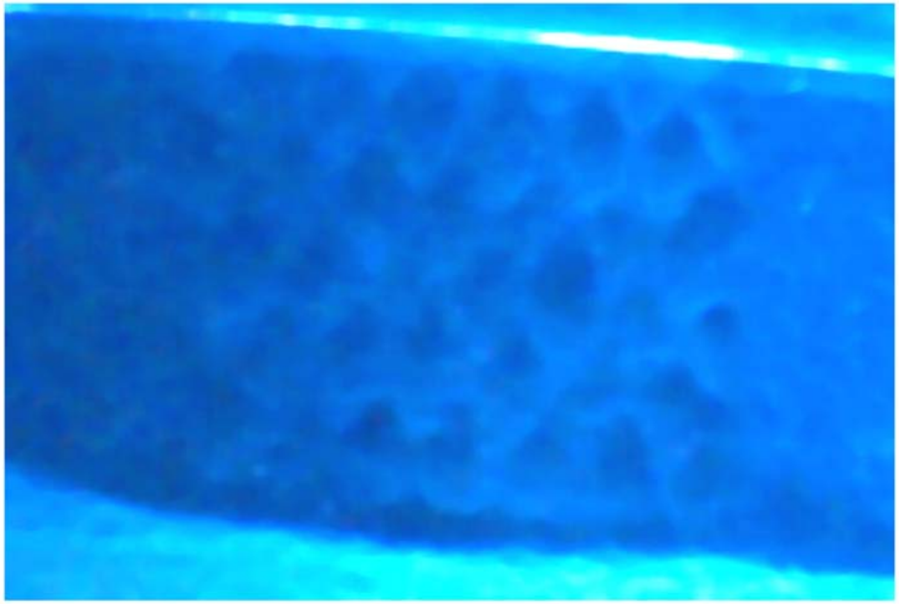
Experimental Configuration



CR-39 in close proximity to the cathode because high energy particles do not travel far

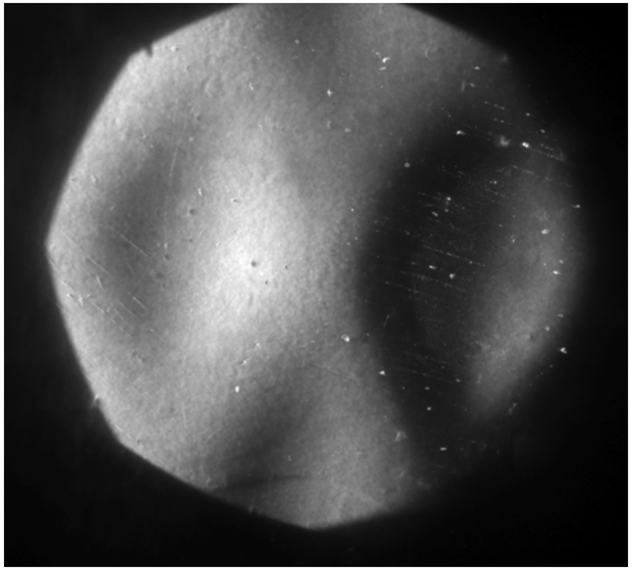
CR-39: Evidence of X-Ray Emission

In the absence of a field



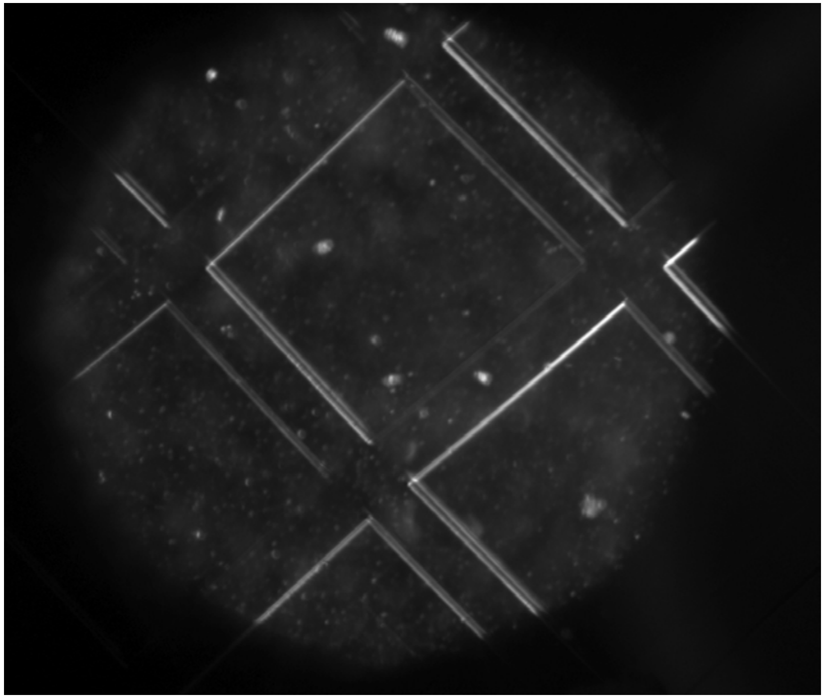
10X

20X



CR-39 Chip exposed to X-rays

20X



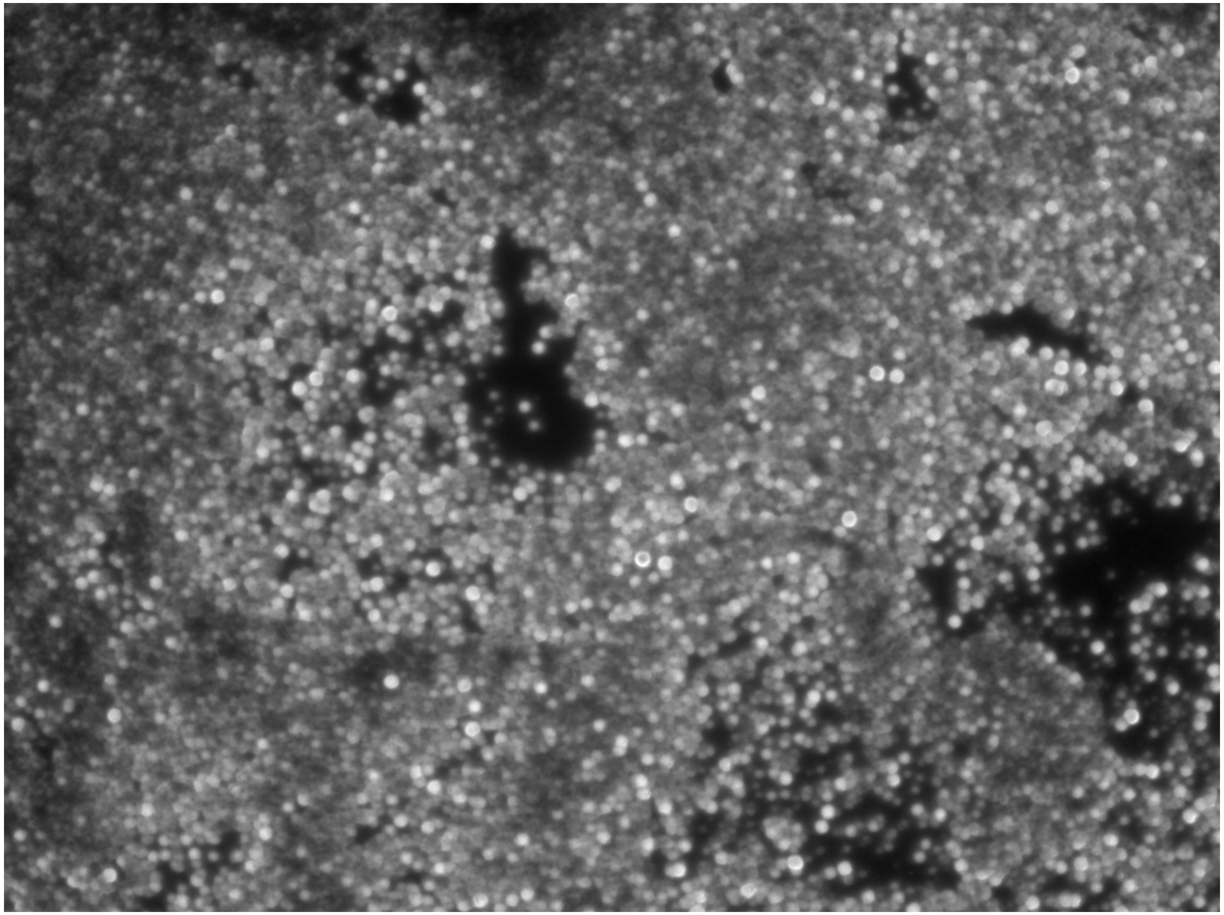
Use of CR-39 for γ-ray dosimetry has been documented in:

1. A.F. Saad, S.T. Atwa. R. Yokota, M. Fujii, Radiation Measurements, Vol. 40, 780 (2005)

2. S.E. San, J. Radiol. Prot., Vol. 25, 93 (2005)

3. A.H. Ranjibar, S.A. Durrani, K. Randle, Radiation Measurements, Vol. 28, 831 (1997)

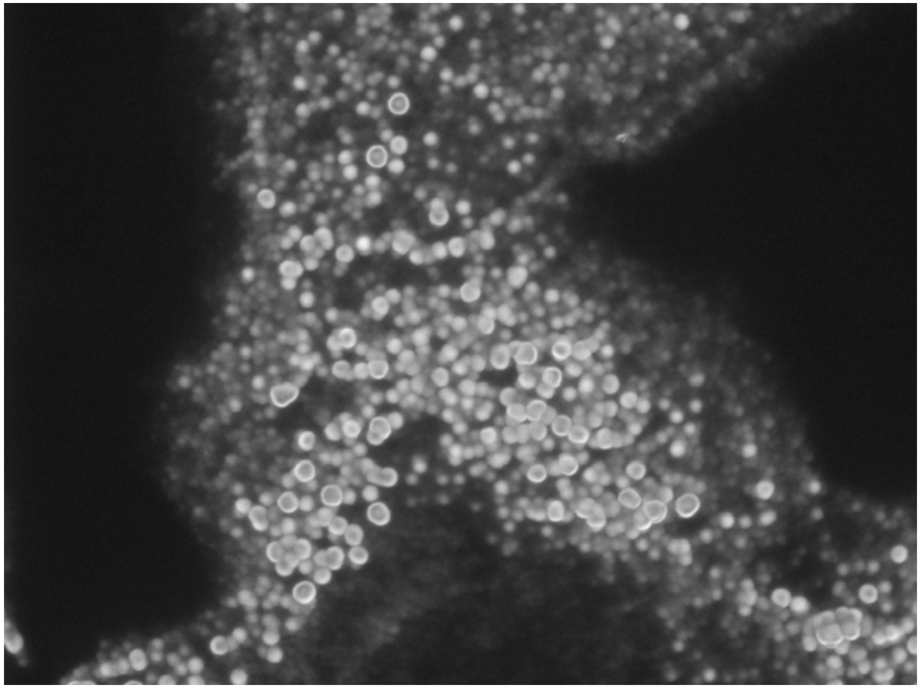
Ni/Pd/D Evidence of Particle Emission in a Magnetic Field

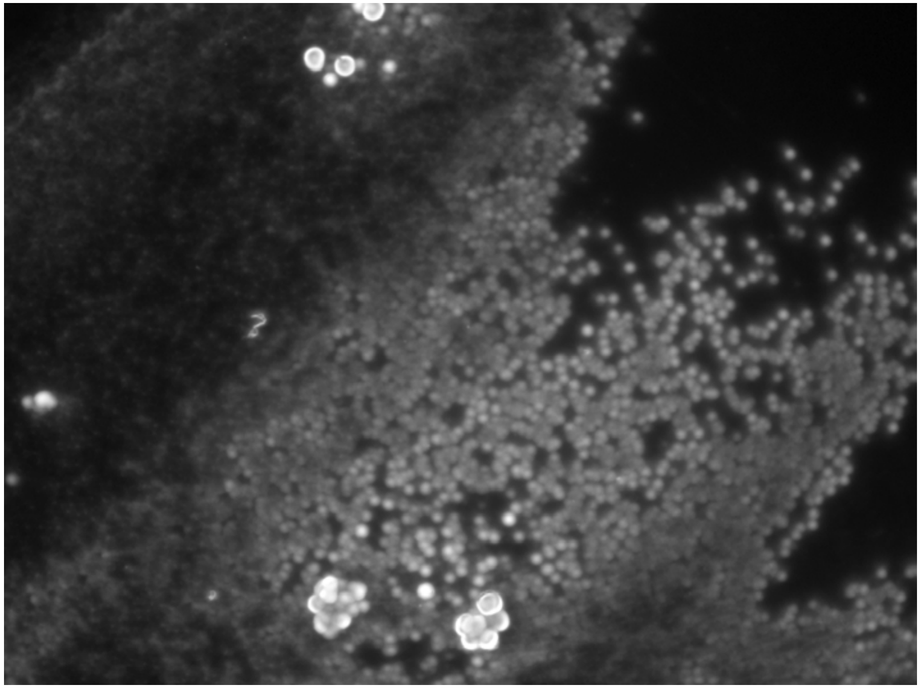


200X

See numerous tracks due to high energy particles. When plated on Ni, tracks are homogeneous in size.

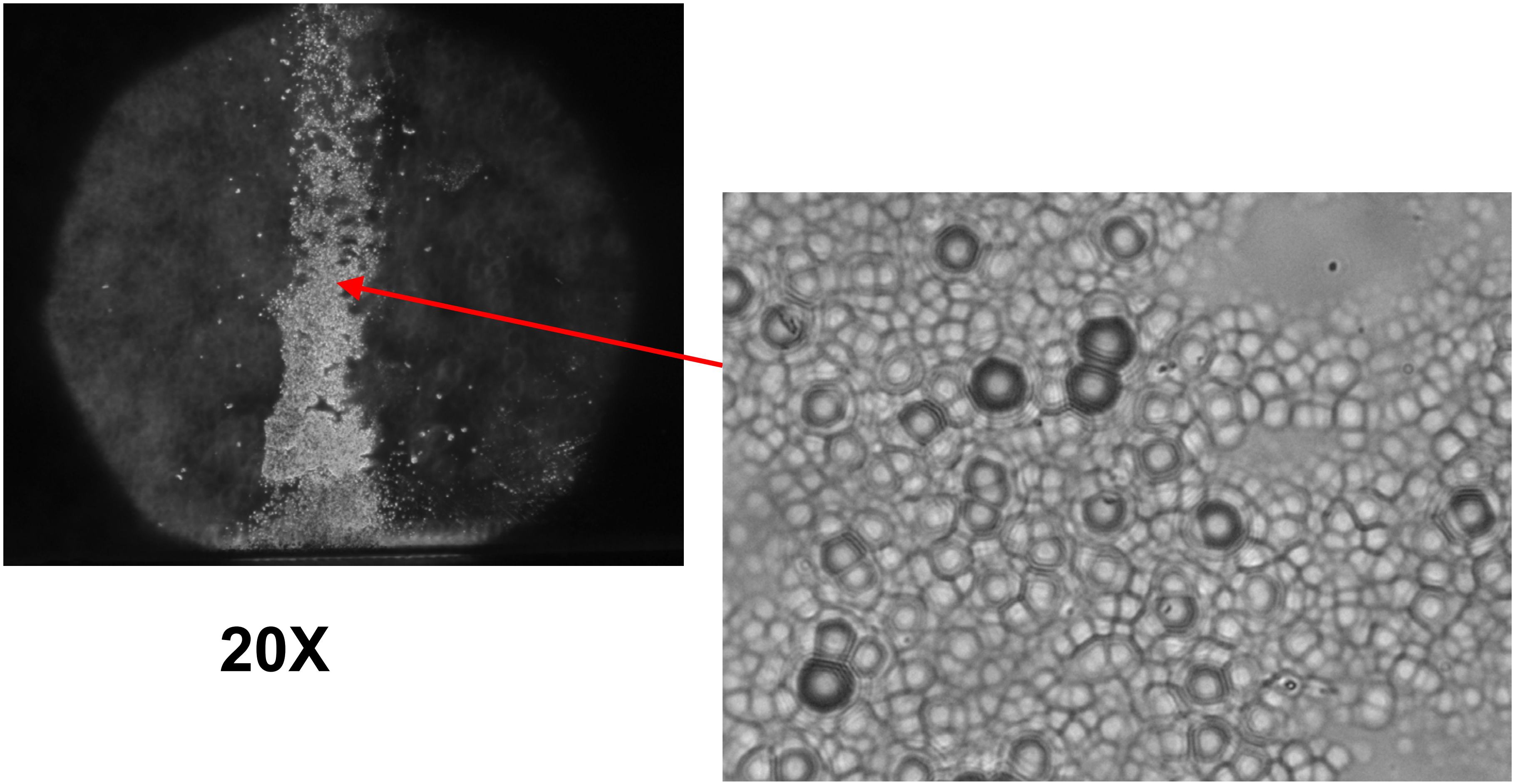
Ni/Au/Pd/D in Magnetic Field





In contrast to experiments performed using Ni substrates, both large and small tracks are observed for experiments conducted on Au, Ag, and Pt surfaces.

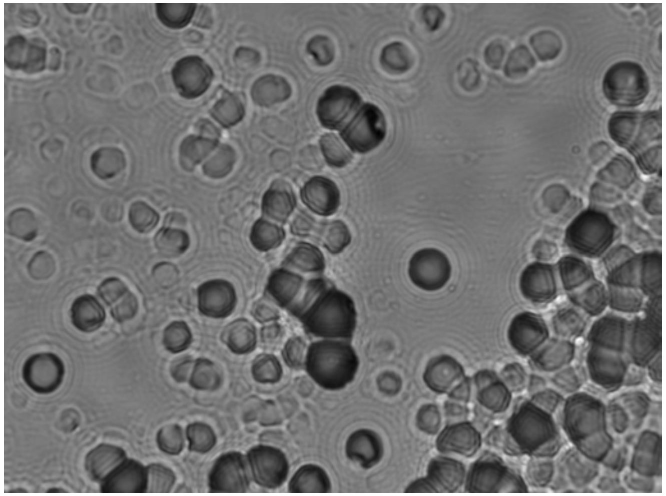
Au wire/Pd/D in Magnetic Field

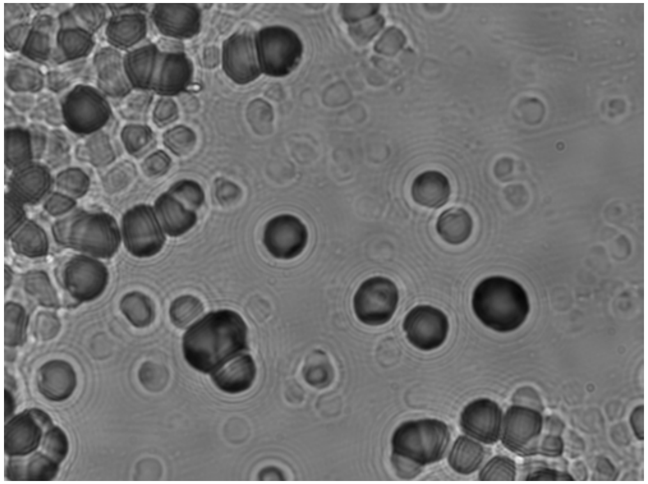


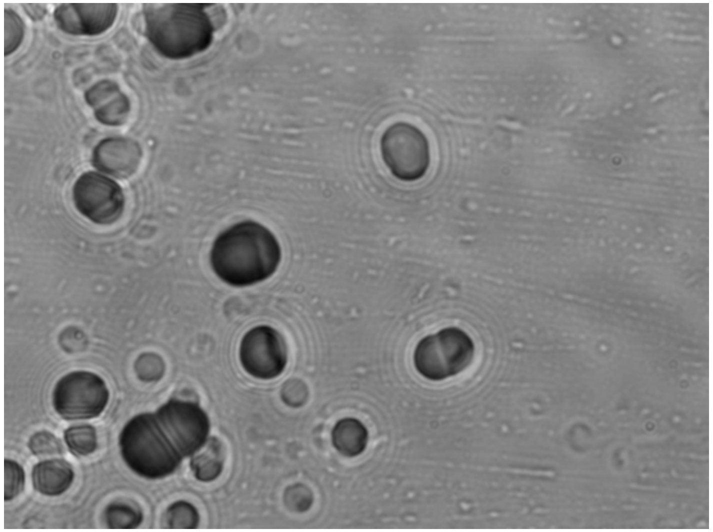
20X

500X

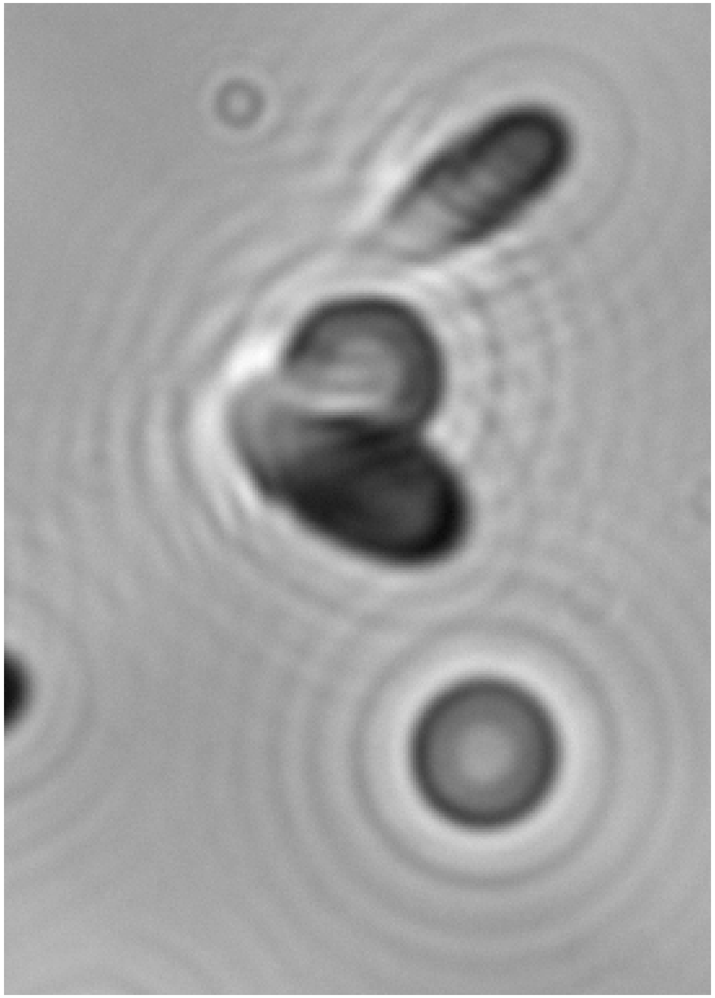
Ag wire/Pd/D in Magnetic Field



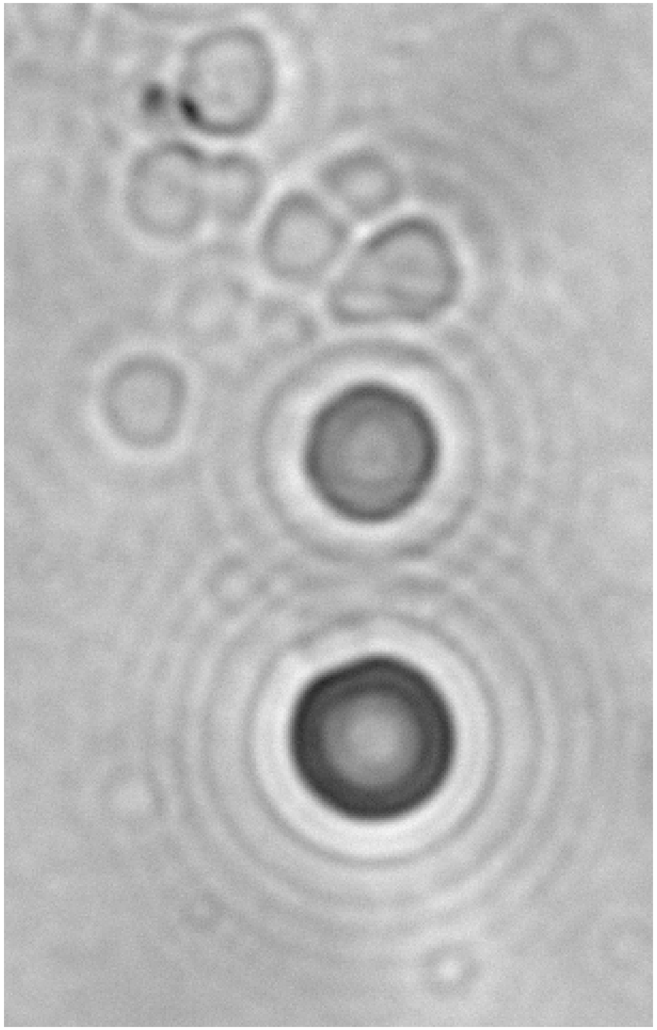




Comparison with Depleted Uranium



Depleted Uranium,
500X



Au/Pd/D, 6000 V E
Field 500X