Kowalski, L., et al. *Charged particles from Ti and Pd foils*. in *Eleventh International Conference on Condensed Matter Nuclear Science*. 2004. Marseille, France.

Charged particles from Ti and Pd foils

Ludwik Kowalski[1], Steven E. Jones[2], Dennis Letts[3] and Dennis Cravens[4]

(1) Montclair State University, Upper Montclair, NJ, USA. (2) Brigham Young University, Provo, Utah, USA. (3) 12015 Ladrido Ln, Austin, Texas USA, (4) Cloudcroft, NM 88317, USA

After familiarizing himself with the use of CR-39 detectors, about a year ago, the first author asked Steven Jones to send him a TiDx foil, similar to that described at the Tenth International Conference on Cold Fusion (1). It was an attempt detect 3 MeV protons with the CR-39 chips. The idea was to develop an experiment suitable for student-oriented cold fusion projects. That is how the first author became a cold fusion researcher. After receiving the foil he sandwiched it between two CR-39 detectors for the period of 55 days. The area of each detector was one square inch. The exposure started three days after the sample was prepared (by keeping the titanium foil in deuterium gas at high temperature and pressure).

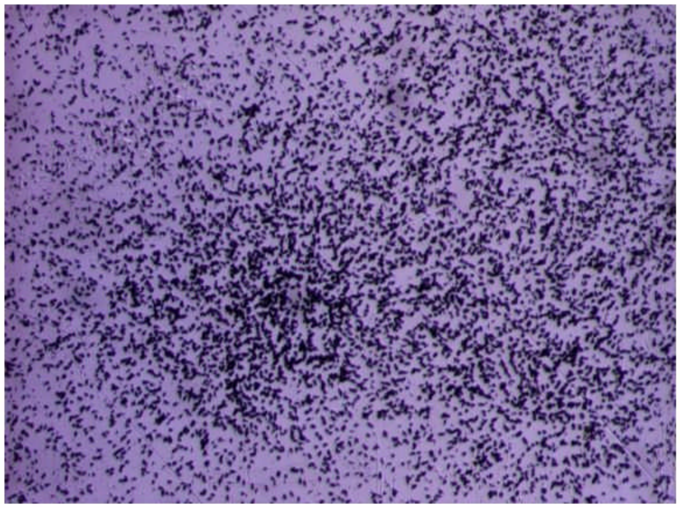
The number of tracks counted on the face of the CR-39 detector that was applied to Jones' foil turned out to be 225. The opposite side of the same CR-39 detector (exposed to air) was used to count tracks due to our background. The number of background tracks turned out to be 132. Such results, if generated by a Geiger counter, for example, could be used as evidence of charged nuclear particles being emitted from the foil. The difference 225-132 = 93 is 4.9 times larger that the standard deviation of 18.9 (calculated as the square root of the sum of 225 and 132). A Montclair State University student, Marcee Martinez, was then asked to count the tracks again. First she "trained her eyes" by observing a CR-39 chip with tracks from alpha particles. Then she started counting "similar tracks." Her result was 165 for the signal and 124 for the background. This time the difference, 41, is 2.4 times larger than the standard deviation.

Are conventional standard deviations, 19 and 17 (as above), appropriate indicators of uncertainty? They are probably not. A human being counting tracks must frequently decide to either count or not to count a particular track-looking spot. The uncertainty associated with counting, the error of rejection, must be added to conventional standard deviation. The conventional standard deviation becomes negligible when the number of counts becomes very large but the error of rejection remains a constant fraction of the total number of counts. Suppose the counting situation is such that hesitation happens in 10% of cases and that the total number of counts is 900. In that case the error of rejection is probably close to 45 (5% of all counts). The conventional standard deviation (the square root of 900) is 30 and the sum becomes 75. The result should be reported as 900 plus or minus 75, rather than as 900 plus or minus 30.

Richard Oriani (2) found a way to practically eliminate the error of rejection. But his method is more labor-intensive than the method we used. Instead of two detectors, one for the signal and one for the noise (background), as we did, he uses the same detector for both. This is accomplished by etching a single detector twice: before the experiment and after the experiment. After the first etching the surface is photographed through a microscope, field by field. In that way the preexisting background is recorded. The second etching takes place after the experiment and the same fields are photographed again. Then the photos are compared, again field-by-field. Only tracks that appeared after the experiment are counted. By his method the net signal of 132, for example, would indeed be much more convincing.

Fortunately, this was not a problem to worry about in another project involving track detectors. That project resulted from correspondence with Dennis Letts. He has a team of scientists investigating excess heat produced in electrolytic cells. Knowing about their apparent electrolyte boil-off (3), the first author asked for a chance to look at a possible "nuclear signature." Three palladium cathodes: Pd-613, Pd-616 and Pd-615 were sent to the first author and he exposed them to the CR-39 detectors. The technique was the same as for the TiDx foils; the cathodes were sandwiched between pairs of detectors for several weeks, detectors were etched, and tracks were counted, under the microscope.

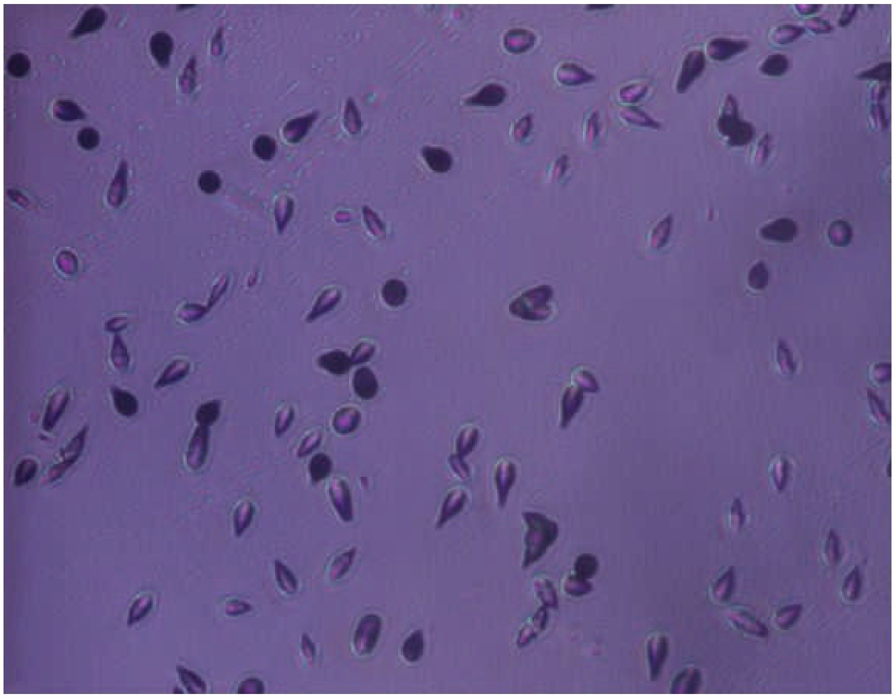
The results were: (a) about 500,000 tracks on the two detectors sandwiching Pd-613, (b) about 11,000 tracks on two detectors sandwiching Pd-616 and (c) no tracks above the background for the Pd-615 cathode. These numbers are rough estimates, errors by the factor of two, or so, are not important in this particular context. Only then was the first author informed that the Pd-613 generated an unusually high amount of excess heat, the Pd-616 generated much less excess heat, and Pd-615 generated no excess heat at all. He was also informed that all three cathodes were cut from the same sheet of pure palladium and that the electrolyte used in the cells was prepared at the same time and kept in a container. The only difference was that several drops of an additive, labeled "sauce," were added to the electrolyte in which the Pd-613 cathode was used. That additive was known to contain a tiny amount of uranium.



Pd-613 magnification 40 (in the cluster)

The above picture, taken through a microscope, shows tracks over the area of the detector equal to 1.30 by 1.00 square millimeters.

After learning about this the first author asked for a sample of this sauce. Several drops of it were placed on a sheet of plastic and dried under a lamp to produce a layer of a dark residual. The CR-39 was at once deposited over that residual. At the same another CR-39 was applied to the most active side of the Pd-613 cathode. Three weeks later the detectors were removed. They immediately revealed a large number of tracks. In fact the maximum track density at the cluster from the Pd-613 was essentially the same as three weeks earlier. These facts are consistent with the idea that excessive tracks were due to the contamination of the electrolyte to which the “sauce” was added. The very large difference between track densities from Pd-616 and Pd-615, on the other hand, could not be blamed on contaminations because in these cases the electrolyte (and other materials) were exactly the same. The Pd-616 produced excess heat and generated nuclear tracks; the Pd-615 did not produce excess heat and it did not generate nuclear tracks, above the natural background level.



Pd-613 magnification 200 (in the cluster)

The above picture, taken through a microscope, shows tracks over the area of the detector equal to 0.25 by 0.19 square millimeters.

Nuclear signature seems to be real:
It is important to emphasize that the "contaminating sauce" was not added to the electrolyte in which the other two cathodes (Pd-616 and Pd-615) were used. And yet the number of tracks due to the Pd-616, roughly 11000, was found to be about 100 times higher than the number of tracks due to the Pd-615. This indicates that nuclear particles were detected at the surface of the Pd-616 cathode, long after the electrolysis. A skeptic might suspect that another alpha-radioactive contaminant (not the "sauce") might have been accidentally added to the electrolyte in which the Pd-616 cathode was used. If this were the case then both surfaces of the Pd-616 cathode would produce about the same number of tracks. In reality one side of the Pd-616 produced 8000 tracks while the other side produced 3000 tracks. How can this be explained? The electrolytic cell was essentially mirror-like symmetric (a small cathode near the center and a spiral platinum anode, parallel to the walls of the beaker). Furthermore, clustering of tracks was discovered on the more active surface of the Pd-616 cathode.

The tracks due to the Pd-613 cathode, by the way, were also distributed very unequally. One side produced nearly 500,000 tracks while another side produced only about 4,000 tracks. Most of the 500,000 tracks were found in a cluster whose area was only a small fraction of the cathode area (see the figure below). It is difficult to explain strong clustering in terms of the contamination of the electrolyte. A more natural explanation is to assume that a very high concentration of tracks in a small area (about 2 or 3 mm) coincided with the spot at which heat was generated during the experiment. A tentative conclusion is that uranium contamination, in the case of Pd-613, was responsible for only a small fraction of what was actually observed.

The first author agrees with the second author that excess heat demonstrations, designed to convince that something highly unusual (cold fusion) is taking place, should always be accompanied by attempts to display nuclear signatures. After all, there are many non-nuclear ways to generate excess heat, especially at the power level below one watt. A complete examination of all chemical processes taking place in a setup (to rule out chemical origin of excess heat) is much more demanding than using a nuclear detector of some kind. Cold fusion effects, if they are nuclear, must generate nuclear reaction products, either radioactive or stable.

References:

1) Jones, S.E., et al. “Charged-particle Emissions from Metal Deuterides.” in Tenth International Conference on Cold Fusion. 2003. Cambridge, MA. This paper can be downloaded from the library at <http://www.lenr-canr.org

2) Oriani, R.A. and J.C. Fisher. Energetic Charged Particles Produced in the Gas Phase by Electrolysis. in Tenth International Conference on Cold Fusion. 2003. Cambridge,MA. This paper can be downloaded from the library at http://www.lenr-canr.org.

3) Letts, D. and D. Cravens. “Laser Stimulation Of Deuterated Palladium: Past And Present,”. in Tenth International Conference on Cold Fusion. 2003. Cambridge, This paper can be downloaded from the library at http://www.lenr-canr.org.