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Following Nature’s Documents
Stan Szpak
LENR Co-Deposition

A Cold Fusion Now Short Film by Ruby Carat
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Featuring:
Dr. Stan Szpak, Electrochemist, former Navy SPAWAR Systems Center [GREEN]
Dr. Frank Gordon, Engineer and former Senior Executive Service SPAWAR [BLUE]
Dr. Melvin Miles, Electrochemist, former Navy China Lake Research Laboratory [RED]

“My advice to those who wish to learn the art of scientific prophesy is not to rely on abstract reason, but to decipher the secret language of Nature from Nature’s documents: the facts of experience.”
— Max Born, Experiment and Theory in Physics

“You see, this is the guiding thing!” — Stanislaw Szpak

Frank Gordon: When the March of 1989 announcement came out, at that time I was head of the anti-submarine warfare department and we had about 450 scientists and engineers, and included in that group were two electrochemists, Stan Szpak and Pam Boss, both PhDs, and they were working on high energy density batteries.

Of course, Stan and Pam were both electrochemists, and also good experimentalists.

Melvin Miles: Well, we were friends and we’d talk at meetings and we’d talk about cold fusion, and we weren’t able to work together until the Office Naval Research people realized that we had some promising results.

Frank Gordon: Being electrochemists, they knew a little bit about chemistry and what reactions might be taking place, and also, they knew Fleischmann in advance. So they had some knowledge of what Fleischmann was doing.

Stan Szpak: I was listening, and I found that there was complete misunderstanding; there’s essentially chaos in there.

Frank Gordon: Whereas a lot of people set out to try to replicate what they thought Fleischmann had done—and there’s a difference between what they thought, and what he’d actually done…So a lot of people, impatiently, started with a bulk palladium rod of some unknown origin, and electrolyzing it, and assumed when they didn’t see results in a matter of hours or a couple of days, they thought, “Well, this is wrong.” And they assumed Fleischmann had made a mistake, rather than that they had made a mistake.

Fortunately, Stan and Pam, being electrochemists, went about it differently.

CO-DEPOSITION

Stan Szpak: You have to define your initial conditions—you have to know what you are dealing with!

Frank Gordon: And Stan came up with the idea of co-deposition which actually was a brilliant stroke, because in the process of depositing palladium onto the cathode, he was also evolving the deuterium there, and loading it into the palladium lattice as it was building up.

Stan Szpak: What is so interesting about it [cold fusion]? People were saying, “It takes so long, several days or something, to charge, and then, it takes weeks before the onset of reaction. What happened in the meantime?”

I knew that I could get a high D/Pd ratio very fast by simply co-depositing, in other words, by plating out in the presence of evolving hydrogen.

Melvin Miles: You apply a small current in the beginning that is large enough to evolve deuterium from the D_2O solution at the cathode. At the same time the cathode reacts with palladium ions, and palladium ions pick up two electrons from the cathode and plate out as palladium metal.

So you have two processes going on at the same time, that’s why it’s called co-, and you’re depositing deuterium from the solution and palladium also from the solution on to a substrate, usually copper, and you form your own palladium already loaded with deuterium as you plate it out.

Stan Szpak: This is a very well known procedure; there’s nothing new about it. But what does it do here? It eliminates the question do we have a full charge or do we not, and all sorts of questions are answered.

Melvin Miles: The main feature is that you make your own palladium by plating the palladium from a palladium salt out of solution, so you have a high purity of palladium, for one thing, and you make it yourself. You don’t have to buy it, you don’t have to depend on the metallurgy of some other company, you just make right there and so therefore it has a much better chance of being reproducible, I think. And that was the main attraction, that it could be a reproducible experiment.

REPRODUCIBILITY

Frank Gordon: Several things resulted from that. First of all, reproducibility was very high. Second, you didn't have to wait two weeks. In fact we could see evidence of the cathode heating up within a few minutes, where it would be hotter than the solution.

Stan Szpak: That is easy to do. What is difficult is that most people don’t know how to do it, and what will happen? They will have a falling-down, nice black powder.

Melvin Miles: A lot of them had problems though with getting excess heat, just like I didn’t know what the problems were. If their cell was too small, they weren’t plating out enough palladium, and if their calorimetry was not accurate enough, they would not see it anyway.

Stan Szpak: The problem is that you have to start with a very small current to deposit at least two or three monolayers of palladium. You see, if the palladium is so thin, it will not take the hydrogen or deuterium.

Deuterium does not penetrate, if you have say, gold, and then you deposit a little bit of palladium, for these first three layers, the hydrogen or deuterium will not absorb. That gives you the reason that you can build up, and the [deposited material] will not be falling off.

Melvin Miles: Well, it was frustrating because I didn't understand some things at that time.

For one thing, my cell was small, the solution concentration was the same as theirs but they had a much larger cell, so they were plating off a lot more palladium than I was.

I later figured out I was only plating off 0.01 cubic centimeters of palladium, and typically in my experiments, I'd get about 1 Watt per cubic centimeter, and such a small amount of palladium was being plated, the most I would likely see would be 10 milliwatts, and my calorimeter could only measure when it was above 20 milliwatts, so therefore I didn't see it, but I didn't understand that at the time.

It was only when I got an exceptionally high power density would I see an effect. I think 2 out of 34 experiments gave excess heat and when I calculated the power density, because of the small amount of palladium deposited, the power density was—I forget exactly, it was something like 60 Watts per cubic centimeter, much higher than any normal experiment would have given, but it was enough that I could measure it on my calorimetry.

After the program closed down, I got a chance to go to Japan and work at the New Hydrogen Energy Laboratory (NHE), and I took some new ideas about co-deposition with me, and also I had a Fleischmann-Pons dewar cell which is about this big instead of my little tiny test tube, so instead of 18 milliliters, I had 90 milliliters of solution. So when I plated it out, I had five times as much palladium on the surface and that made a big difference, and I also had a much more sensitive calorimetry than the Fleischmann-Pons dewar calorimetry, that can measure within 1 milliwatt.

So when I got to Japan, I had much more accurate calorimetry, I had a much larger amount of palladium that was plated, and I only had six months, so at the very end I ran three experiments on co-deposition, and all three gave excess power, excess heat. Three out of three in Japan, using my new solution, better calorimetry, and a much bigger cell, plating out much more palladium on the surface.

So I think it is reproducible, but you have to get enough palladium that you get enough heat that you can measure.

Frank Gordon: A lot of other people had problems in their experiments and they weren't getting the reactions they thought they should get and so they said, "Well, it doesn't work." And Stan and Pam were having success.

Stan Szpak: If you use it correctly, you will have 100% reproducibility.

EXCESS HEAT

Stan Szpak: My position or my approach is to use everything as simple as you can, don't complicate things.

So now the problem is, we need to find out is it really producing heat?

Well you can start with calorimetry, or you can do a very simple thing. You can take a glass tube, bend it, take a little piece of copper, attach a thermocouple to it, and paste it on the glass tubing, plating on one side, and measure the temperature on the back side, and measure the temperature of the solution.

And sure enough, we see, immediately, heat, excess heat production.

Frank Gordon: So when you look at the amount of excess heat produced, and I've heard Martin say this, if you converted every atom in the cell to energy at 3 or 5 electron volts per atom, there aren't enough atoms there to account for the amount of heat that's been produced. That's how they arrive at the conclusion that it must be a nuclear event.

Melvin Miles: They measured the temperature on the back side of the cathode where the palladium was deposited and it was hotter than the solution, which is unusual, and shows there is some heat production going on at the cathode.

Frank Gordon: And that was counterintuitive, because there was more resistance in the solution than there is in the copper cathode. So the solution should be heating up faster than the cathode, and that wasn't the case. So that clearly indicated to us that the source of heat was in the cathode.

Melvin Miles: But it didn't tell you how much exactly, but I was developing accurate calorimetry that I could measure the excess heat, well mainly the excess power, but power times time is energy, so we'd measure the excess power by the calorimetry.

THERMAL RUNAWAY

Stan Szpak: The question was, what will it do if we prepare the co-deposition in normal, light water, and put then in a magnetic field, and electrolyze?

The first day, nothing happened. The second day nothing happened. The third day, we see a rising temperature of the solution, we have a thermocouple in the solution underneath, and then, bends, and within a minute, boils off and explodes!

Frank Gordon: Anyone who has worked in this field for any length of time probably has had a couple of thermal runaways, and they've probably spent months trying to reproduce it, and can't.

Stan Szpak: If you calculate, you have to conclude there was a tremendous amount of extra heat.

Frank Gordon: When we first started this in '89, we had one experiment we were doing where I think we were sampling it once every 30 seconds, or once every minute, and we came in one morning and the cell was dry, and something had happened.

The electrode had disappeared, and when we looked at the data, everything was fine, we didn't see any huge rise or anything, and then, the next 30 seconds, it was gone. So we missed what happened.

Probably the best reproduction of that that I'm aware of is some work that Stan did with Jack Dea who was another scientist at the lab who was working in this area. This was the light-water and palladium, and in three out of the ten cases, they had a thermal runaway, where the cathode literally, which was a palladium wire or platinum wire, it melted in two, fell down into the bottom of the acrylic cell, and was hot enough that it melted through and melted a hole, and so the solution — through a combination of leaking out of the hole and heat vaporization — disappeared.

And this was three-out-of-ten cases, so that's a pretty significant result.

It's hard to identify exactly what triggers it. In all of the cases, it happened after about three or four days of electrolysis. They were also doing cycles, so maybe 300 milliamps per square centimeter for 90 seconds, and then a complete reversal, down to 5 milliamps per square centimeter for about five seconds, and then back up; they were doing that cycling when it happened.

HOT SPOTS

Stan Szpak: Well there was a Professor Simnad at the university here UCSD, and there was another fellow Evans working from Atomic International. They were using an infra-red camera to photograph the surface to look for the heat, and they saw a rather unusual pattern. When I saw this pattern, I thought why don't we try to do that on a co-deposited cell?

Frank Gordon: Again, that's something that co-deposition allowed us to do, that other protocols would not have allowed. In that case, we had a nickel mesh, a thin mylar window, and we co-deposited palladium onto the nickel mesh and we had the IR camera looking at the backside of it.

Stan Szpak: And what do we see? Spots! Hot spots when you look at this.

Now what does that mean? It tells you that the heat is not produced uniformly over the whole volume, but in certain spots, and these spots are short-lived.

Melvin Miles: They went on to do many different things in co-deposition, with x-rays, radiation, tritium, acoustic studies, where they plated onto a microphone, and they could hear the sounds made by the fusion burst, and it would make noise on the microphone and they measured that. They tested what electric fields do, what magnetic fields do, how that changes things, and did a lot of studies in that area.

They probably published in more refereed publications than maybe any other group that I know of.

Frank Gordon: I could not really judge the quality of their work, but I knew the quality of their character and their expertise. So when they were producing these results, and then they wrote them up in papers and submitted them for peer review, and they were getting published, that provided the shield that I needed to try and keep them going.

You could say, boy that was a stroke of genius, because it allowed you to do the experiment quickly.

There was a huge, significant flexibility. We could co-deposit onto a cathode of about any shape, we could glue a thermocouple right to the back of it in intimate contact, so we could see exactly what we were seeing.

Melvin Miles: [Co-deposition was] a completely new method of doing the study without depending on palladium from some method of manufacture which could vary from one manufacturer to another.

They came up with their own method of making it right in the solution by plating, which gives you pretty much the same quality of palladium every experiment. I think that was a genius stroke coming up with that co-deposition idea.

Frank Gordon: You know co-deposition became the lab rat because it was so flexible and reliable. You know they say, is it better to be lucky or good, and I think in the case of Pam and Stan they were both.

Those were the two people. Without Stan and Pam, we would not have been involved in it. It would have died. There would have been some of the other groups, people who tried it and failed, and it would have evaporated into the woodwork, and wouldn't have carried on.