Cold Fusion Pioneer Richard Oriani, 1920-2015

Christy L. Frazier

Dr. Richard Oriani, a cold fusion pioneer who was the first to place CR-39 inside electrolytic cells in order to detect energetic particles, passed away on August 11 at the age of 95.

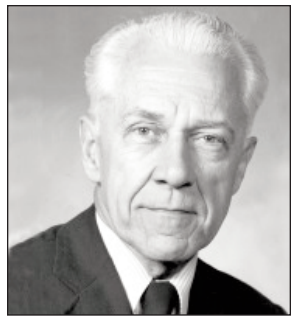
Oriani was born in El Salvador on July 19, 1920. His family emigrated to the U.S. when he was nine years old. Oriani graduated from the College of the City of New York in 1943, with a degree in chemical engineering. He received his Ph.D. in physical chemistry from Princeton University in 1948 while working at the Bakelite Corporation Research Laboratory, where he worked on the study of adhesion and received a patent for a military adhesive.

Oriani went on to work at General Electric Research Laboratory (Schenectady, New York) and U.S. Steel's Bain Laboratory for Fundamental Research. It was at GE that he met one of his main collaborators in cold fusion, John Fisher. Oriani's early work focused on the thermodynamics of phase changes in metals and metal solutions and hydrogen embrittlement.

Oriani was a professor and director of the Corrosion Research Center at the University of Minnesota from 1980 until his retirement in 1999, but he maintained an office and conducted research until last year. It was at the University of Minnesota that Oriani first conducted cold fusion experiments in the summer of 1989.

Oriani was one of the first to verify the Pons-Fleischmann results of excess energy in an electrochemical cell. See "Calorimetric Measurements of Excess Power Output During the Cathodic Charging of Deuterium into Palladium" (http://www.lenr-canr.org/acrobat/OrianiRAcalorimetr.pdf, *Fusion Technology*, Vol. 18, 1990). Charles Beaudette, in *Excess Heat: Why Cold Fusion Research Prevailed* (2000), wrote (p. 192): "Oriani introduced the innovation of a cylindrical glass partition between the palladium cathode at the center and the platinum anode wrapped against the inside wall of the flask. This glass was perforated with fine holes that allowed the electrolytic action to take place while separating the oxygen and hydrogen bubbles in order to ensure that any residual recombination was negligible."

In an interview for the 1999 *Infinite Energy* documentary "Cold Fusion: Fire from Water," Oriani said of these early experiments: "Since I had some background in the area of hydrogen in metals, I thought that I could do something to prove that the announcement was incorrect, that they did not have the right idea. So I began to do some experiments and, sure enough, I got negative results and that went on for about five months. But then I got new metal, new palladium and, by golly, I got two excellent experiments with very positive results, more thermal power coming out than I was putting in electrically, in an electrolysis-type experiment. And that made me a believer. It made me a believer because I could see nothing at all wrong with the experiments…I finally got positive experiments, positive results, that made me realize that there are more parameters here in this field than any one of us had considered before and so it seemed natural that there would be negative experiments because we were not controlling the proper parameters. We just didn't know enough even to recognize what parameters should be controlled…"



Oriani began focusing on the nuclear origins of the excess energy, detecting and quantifying the emission of nuclear particles by electrochemical reactions. He collaborated with many researchers and theorists in the field, most notably John Fisher and Tadahiko Mizuno.

Oriani met Fisher nearly 70 years ago when they were both hired at GE around the same time. Fisher notes, "We worked generally on different projects, but occasionally we worked on the same project. My wife and I got to know Dick and his wife pretty well. We saw each other socially, as well as professionally. My wife and I were at his wedding to his wife Constance." After Oriani left GE, he and Fisher stayed in touch mostly through holiday cards. Then came 1989.

Fisher explains, "A long time passed between our meeting at GE and our collaboration in cold fusion. And then came the Fleischmann and Pons experiment and I became very interested in that and so did he, unbeknownst to me. He was perhaps the first to repeat the Fleischmann-Pons experiment. About a year after the announcement, I attended a conference—not knowing that he would be there speaking—where he spoke on the subject and he had checked Fleischmann and Pons and had gotten the same result. That changed me from a doubter into a believer instantly because Oriani is such a superb experimenter and electrochemist. If he said it was true, it had to be true. And so we then immediately began talking with each other about it."

Fisher details, "Oriani moved from doing measurements of heat to measurements of particles using CR-39 plastic detectors. We talked about that and I worked on a theory. My theory said that it can't be fusion, it's got to be an ordinary type of nuclear reaction at room temperature. There had to be a neutral particle or the reaction couldn't go. There couldn't be neutrons because they weren't found, so there had to be some as-yet-unknown neutral particle that was active. And he understood that and wondered whether it would influence his experiments...He knew me from my pre-

vious work in other fields, that I was a competent theoretician. So just as I accepted his experiment, he accepted that my theory was worth considering. He didn't come to understand it ever, but he did use it. He is the only experimenter, I think, who ever did."

In the 1999 interview for "Cold Fusion: Fire from Water," Oriani said of theory in general and Fisher's polyneutron theory in particular: "I use a theory as a heuristic device to give me some reason for doing an experiment. For me, the more cogent, the more succinct, the more pointed a theory is the better it is as a guide to experimentation, but I cannot say that I believe any one of them very strongly. You look at the universal theories in this field, you find that there are as many theories as there are theorists and they contradict each other very happily, so one does not know what to believe. All I can say is that lately I've been able to verify one aspect, one prediction of the latest theory, the polyneutron theory. Even that is at the present time a tentative acceptance of the interpretation of the results; it still has to be verified by other techniques and I'm taking measures now to try to verify that."

Fisher suggested to Oriani that he place the CR-39 detectors outside of the electrolyte. He says, "Oriani did that and he found evidence of particles that he could record outside the apparatus. He put two plastic detectors in the gas that was coming off the electrolysis...Lo and behold, he got a shower of tracks on those. Thousands of tracks, more than he cared to count." Marianne Macy, in Issue 94 of *Infinite Energy*, highlighted the collaboration of Fisher and Oriani; these selections from both men's oral history is now on our website. The tedious process of Fisher counting the etch pits is discussed, as well as many other details about their work together. (See also the 2004 paper from ICCF11, "Energetic Particle Shower in the Vapor from Electrolysis," online at http://www.lenr-canr.org/acrobat/OrianiRAenergeticp.pdf.)

Fisher says that Oriani used the polyneutron theory on two major experimental efforts. The second collaboration is now a paper in progress on creating the same reaction in a solid, using a stack of two CR-39 detector chips. Fisher notes that they found "tremendous numbers of etch pits, thousands of etch pits." Sometimes they were "not uniformly scattered across the surfaces; sometimes there would be a patch on an outside surface for which there was not a patch for the inside surface. Once there was a big patch on one inside surface that was matched by another patch on the facing inside surface on the other detector chip." After matching up all of the pits and showers, Fisher says "it became clear that the reactions had started in various places in the interior of the sandwich of plastics and in at least one place the reaction had spread from one detector into the other." He calls this "an incredible and terrific experiment" and hopes to finish the paper soon.

Fisher feels that his collaboration with Oriani related to CR-39 "will be the single most important experimental contribution that the two of us make to the cold fusion field. I think that Oriani will be one of the greats of all time, first for his verifying Fleischmann and Pons but more importantly for these experiments using CR-39. Future researchers investigating LENR reactions in cloud chamber detectors will refer to the vapor shower paper, and those investigating in bubble chamber detectors will refer to the sandwich paper."

Oriani confirmed excess heat in the hydrogen proton conductor of Tadahiko Mizuno. Mizuno wrote in his book, *Nuclear Transmutation: The Reality of Cold Fusion* (1997), that Oriani's "experimental technique was flawless." He noted, "His measurement technique was like flow calorimetry in that it showed absolute heat, leaving little chance of error. To perfect it even more, Oriani had sent back to Sapporo [Mizuno's lab] a mixed selection of used conductor samples, some of which had produced heat in Oriani's lab, and some of which had not. He sent along instructions asking me to run them again in my own calorimeter. In short, it was a blind test in which I did not know which samples had previously produced heat." Oriani used a Seebeck envelope calorimeter, which captures and accounts for virtually all of the heat, rather than sampling the temperature at one spot. See Oriani's paper "An Investigation of Anomalous Thermal Power Generation from a Proton Conducting Oxide" (http://www.lenr-canr.org/acrobat/OrianiRAaninvestig.pdf, *Fusion Technology*, 1996, Vol. 30).

Oriani published over 200 articles in peer-reviewed journals during his long career. Many of his cold fusion-related papers are archived on the lenr-canr website (scroll to Oriani's name at http://www.lenr-canr.org/acrobat/). He received the Alexander Von Humboldt Prize and the W.R. Whitney Award of the National Association of Corrosion Engineers.

Oriani said of cold fusion in 1999: "I believe that any new idea in science has to fight its way into the marketplace. I think that's reasonable, to be expected and healthy. The problem with cold fusion is that there has been a great deal of active hostility and vituperation, emotional reaction that is really out of place and should not have happened..." He said to Marianne Macy in a 2010 oral history interview that if cold fusion becomes a reality "it would open up a new area of nuclear physics entirely. It would augment nuclear physics as we understand it today."

Dr. Richard Oriani is survived by his wife of 66 years, Constance, four children and eight grandchildren.

Below are some additional commentaries by colleagues of Dr. Oriani. Following is a piece by Marianne Macy entitled "Richard Oriani's PACA Protocol," which includes excerpts from his oral history interview.

— Michael McKubre —

I first met Richard (Dick) Oriani well before cold fusion was ever dreamed of, under most auspicious circumstances. Dick was a featured speaker at a Gordon Conference I attended in New Hampshire in approximately 1980, a couple of years after I came back to the U.S. to join SRI. This conference series, amongst the most prestigious in the U.S., attracts the "best and brightest" from around the world. Dick was clearly one and in his element. I remember listening long to Dick, impressed with both his clarity and depth of conversation. His reputation, well-justified in both person and publication, was of extreme technical competence in the fields of that conference—aqueous corrosion and metallurgy—and beyond. Rumor had it (later verified) that Dick had been the man chosen by GE to prove by practice that their patent on diamond production by synthetic routes did indeed teach. Armed only with the patent and "ordinary skill in the art" (in his case clearly extraordinary) Dick was able to generate diamonds from the written words and his ability. The patent was deemed valid.

I kept track of Dick over the years and our paths crossed often. I was delighted to see him surface in cold fusion shortly after the fateful Fleischmann and Pons announcement with a positive calorimetric result. Dick's efforts and results confirmed a pattern beginning to emerge. The technically well-skilled were able to demonstrate a positive confirmation and affirmation of what now is the Fleischmann-Pons Heat Effect, while for the technically less able this proved to be a challenge to either skill or patience. The world and the cold fusion field are both better places for Richard Oriani's contributions to them. I am honored to have known him.

— Charles Beaudette —

Oriani's very early confirmation of the excess heat effect in the early fall of 1989 was a significant accomplishment. *Nature* journal came close to publishing it, but ultimately lacked the courage. The government's Panel on Cold Fusion closed its acceptance window just weeks before his confirming paper was available. One of his later contributions was to repeat a Mizuno experiment that used a proton conductor and a perovskite ceramic raised to 400° Celsius. When charged with deuterium gas it too exhibited excess heat. In one run it showed excess heat without electrical excitation. I looked upon Dr. Oriani as one of the best scientists in the field.

— Pamela Boss —

Isaac Newton wrote, "If I have seen a little further it is by standing on the shoulders of giants." The LENR community has lost another one of its giants. Richard Oriani was a metallurgist, an expert on metal hydrides and hydrogen embrittlement, and corrosion. He was among the first to verify the excess heat results of Pons and Fleischmann and to experience the editorial bias on publishing positive results in top tier journals. He, along with John Fisher, was the first to place CR-39 inside electrolytic cells in order to detect energetic particles. His insights and experience will be sorely missed.

— Ludwik Kowalski —

Richard Oriani was my mentor, as far as using CR-39 detectors was concerned, during my one-week-long stay in Minneapolis. But we also had chances to interact in dealing with other topics of general interest. Both Richard and I worked in the controversial area of science known as "cold fusion.' First we believed that our results confirmed sensational claims made by famous electrochemists, M. Fleischmann and S. Pons. But then we became aware that such conclusions were premature. That does not mean that the field is dead; it seems to be more complex than originally described. Will future scientists recognize Oriani as an important contributor? I hope so. In any way, I am not the only one among those will remember him as an admirable mixture of a dedicated scientist and a generous person.

Richard Oriani's PACA Protocol

Marianne Macy

The consummate scientist, Richard Oriani never stopped learning. In 1980, after his retirement at ago 60 from U.S. Steel Lab, he was recruited by the University of Minnesota to be a professor and first director of the newly established Corrosion Research Center, where he was in 1989 when the Fleischmann-Pons news broke. His contributions to LENR are extensive and recorded in the literature of the field. One that he did not manage to publish (he tried seven journals) was the creation of what he called the PACA protocol, which stood for Protection Against Chemical Attack. His questioning mind would take things even further than possible chemical contamination, and his considerations offer valuable insight. Taking a look at his thinking on this topic could save researchers much trouble in terms of having their results questioned when they use plastic nuclear particle detectors, as well as giving direction for how best to work with these diagnostics.

In a 2010 oral history interview, Oriani explained how he arrived at the PACA Protocol while considering photos of CR-39 results of neutrons by a group of researchers: "I saw their pictures and I said, 'My gosh, it looks like a chemical attack.' So I did their co-deposition experiment using their technique entirely and I found that, yes, there were nuclear tracks but also a much larger number of chemical artifacts. See, what happens when you electrolyze is that at the cathode you break up water and that produces hydrogen gas, oxygen at the anode, but at the cathode you produce hydrogen gas plus hydroxide ions. The hydroxide ions are the thing that etches the CR-39 detectors. When one puts the cathode wire directly upon the plastic of the CR-39 detectors you generate hydroxide ions. You generate the etchant solution right smack on the chip. Therefore you are etching a chip."

What is the problem with that? Oriani continued, "Instead of seeing only nuclear tracks, one is seeing a vast majority of chemically produced pits. My thought was if you are going to convince a skeptic with this, good luck. He can say, 'My gosh, you've got all this chemical attack; I don't believe what you say that you've got.' So I said to myself, 'We have to avoid chemical attack.' A simple way of doing that is to interpose another piece of plastic, maybe a 6-micron thick Mylar film. Which I did, and I

observed tracks completely free of chemical attack." He added that doing this led to success subsequently in getting results with 100% reproducibility. "This is done by having the cathode wire rest upon the Mylar, which in turn rests upon the CR-39 chip. So all of the action was very close to the recipient, the detector chip. By doing this I was able to observe time after time that I was getting nuclear tracks completely free of any possible chemical attack. I call that a PACA Protocol, Protection Against Chemical Attack."

Oriani proceeded with this work, in the process of which he observed a phenomenon which puzzled him. He came to call it the hot O-ring effect. "The hot O-ring effect, which only sometimes appears, is the following," he said. "The O-rings are part of the clamping mechanism for holding a CR-39 detector in place under the electrolyte solution. After an electrolysis experiment, I take one of the used O-rings and place it on a piece of CR-39 and the assembly is wrapped tightly in aluminum foil and set aside for three or four days. After etching the CR-39 I find a tremendous number of nuclear tracks that not only follow the perimeter of the ring but are also in the center. The latter could not have been produced by any contaminants, if any had been present on the O-ring. I kept looking at this over and over again. I became convinced that this phenomenon is really very significant although it did not happen all the time. This lack of reproducibility is a characteristic of this field, I am afraid."

What did Oriani think was happening with the O-ring? "I think it was caused by some sort of reaction with some of the ingredients in the O-ring. I didn't try any other kind of O-ring. I was busy with this one set of O-rings, which I had gotten from a chemical house. I sent one of the O-rings to Marissa Little's lab, who examined it and became convinced that the phenomenon was due to thorium contamination. She observed lines in the alpha spectrum of the O-ring which correspond to the thorium emission particles. Thorium is radioactive. However, one important line in the thorium spectrum does not appear in the O-ring spectrum that must appear if indeed thorium contamination is involved. Hence, I regard her work as not conclusive. At the present moment it remains up in the air as to what is really going on, whether nuclear contamination of some sort is responsible, or whether it is a real effect. Although I've carried out many controls to rule out contamination, I have not been able to get back to that yet. But I intend to," he said.

Oriani emphasized that he felt convinced of the verisimilitude of results involving nuclear tracks in some groups' work he had seen, because of particular markers, namely, the appearance of the pits. "One can distinguish between chemical and nuclear tracks by looking at the geometry of the pit in specimens. (Some I have seen) are correct but other claims are a bit more suspect in my mind, namely what they call triple tracks. I get them too; I get triple, quadruple, quintuple tracks."

Do results such as triple tracks represent neutron disintegration? Oriani thought it important to be sure, as results could be complex. In some experiments he did see that researchers had obtained nuclear tracks. But also he believed they had obtained a far larger number of chemical pits, a problem that Russian researchers Andrei Lipson and Alexei Roussetski had also run into. "My thinking was that if we wanted to convince skeptics that cold fusion is a real phenomenon, we had better avoid chemical effects because they are by far the most abundant phenomenon there. That's why I have developed what I called the PACA Protocol, where I interpose a Mylar film between the chip and the electrolyte," he said. Researchers find triple tracks which they interpret as related to neutrons. "I think that is suspect. I see triple tracks, quadruple tracks, and quintuple tracks. So to understand the triple tracks I think you have to understand also the generation of other multiple tracks coming from one point instead of jumping to the conclusion that the triples are in fact from neutrons."

Oriani considered this problem repeatedly, in his own work with CR-39 detectors and in looking at photos of other researchers' CR-39 results that showed multiple tracks originating from one point. He didn't see them all the time, but when he did, he felt it was important to understand the multiple track situations. "Why are there four? Why are there five? What caused them in the first place?" One notion, he noted, that it's a carbon-12 decaying into three alpha particles, was an explanation for triple tracks. But Oriani cautioned this was a hypothesis. "In other words, it's not enough to see three tracks from one point and jump to a conclusion that that's the disintegration of carbon-12. Because there are other possible track configurations." Oriani spoke of Russian physicist Andrei Lipson and his work, saying it was a great effort done to not only identify that there is a track present but that there is associated with it energetics of a particular kind which can be associated with protons or alpha particles or whatever. Lipson's work utilized the absorptive properties of various metal films, copper and aluminum, coupled with the use of americium and other particle-emitting materials. Lipson's process was to use layers of different metals with different absorption properties for different alphas and protons and other charged particles, "as well as different thicknesses, so you should see a displacement in the depth of the tracks, as a consequence of having to absorb some of the energy. The particle makes the CR-39 generate a track. It's that sort of thing for particle identification that you would hope to see in anybody who is saying what is giving the track," Oriani added. He considered an experiment in which Lipson simply took a small Tesla coil and ran across the surface of a CR-39, in which he showed you could also generate lots of pits in the plastic. "Which, if you put them into an automatic reading machine, would be read as tracks, not as pits." Oriani recounted other complexities he'd observed when trying to puzzle out what was or was not an indication of a nuclear effect.

"Often an O-ring—which I had used in a successful electrolysis—acquires the power to emit nuclear particles. If I put an O-ring that has been used before in a successful electrolysis experiment on another CR-39 chip, not all the time but often, I get a ring of tremendous concentration of nuclear tracks. Of course, it may be claimed that this was caused by contamination in the O-ring, but I not only see the tracks along the perimeter of the O-ring on the CR-39 but also in the center where the geometry would be such that I could not possibly get any tracks from contaminants on the O-ring. I sent one of those O-rings to Little's group at Earth Tech, and they put it through some complicated paces and found that the spectrum that they observed matches that of thorium, except that a very important and significant line that thorium emits does not show up in the O-ring spec-

trum." He added that the group was doing gamma counting. "In my mind," he said, "their work does not conclusively prove contamination on my O-rings. But I do not know what is going on. I have not been able to get back to that work." He added that another worthwhile experiment would be to put the O-ring before the experiment onto a CR-39, then put it into the experiment so as to have a before and after on the O-ring as well.

And what about the state the O-rings are in? "What I have done is that I have checked O-ring after O-ring that I've received from the manufacturer and I have never observed anything untoward. These things are dead, nuclear-wise. These things are not pre-contaminated." To check them, Oriani would put them on a CR-39 chip for several days wrapped up in aluminum foil and just lay them aside.

Oriani recommended further work in this area. "What I have not done is the following, and it is stupid not to have done it: take an O-ring as received from the manufacturer, place it on a CR-39 chip, etch that chip to find out if there is any activity, and then use the same O-ring in an electrolysis, and then place that O-ring on another chip to observe the hot O-ring effect. I think this phenomenon remains to be explored some more...I've been very concerned about that and so as I said before I have been etching the plastic as I receive it, and then I go ahead and use those etched chips. But that has problems too. It turns out that very often, not all the time, the deeper etching brings one into a region of defects in the polymer. I think that these defects are probably due to regions of the polymer that are not fully polymerized. Then when that region is reached by the etchant then little pits are produced which can deceive one into thinking that it is a nuclear effect."

Oriani counted thousands and thousands of tracks to consider indication as to the level of activity. In a visit to his home laboratory, he showed a ring of haze corresponded to the perimeter of the O-ring. The chip on which the O-ring had been placed shows a huge constellation of tracks. He stated another experiment he would suggest would be to put a piece of Mylar between the O-ring and the chip and seeing if it made a difference.

Oriani's chemical activity concerns were exacerbated by Lipson's illustration that many of the tracks which were attributed to being nuclear tracks in some experiments using CR-39 would disappear when the chip surface was etched. So what seemed like extremely high levels of nuclear activity was actually chemical in origin. Finally, Oriani considered the handling procedure that the transportation services such as TSA employ while checking for explosives. Anything that goes through an airport these days has a real high probability of hitting a neutron activation examiner.

This was yet another factor of considering contamination, Oriani mentioned. In dealing with this problem of contamination of CR-39, Lipson's practice was to not try to do anything with oblique incidence because it turns out that there is a contamination level which reduces the signal to noise in these chips. He would see it in almost every chip that he got, he reported. Oriani added, "I do something else. What I do is that I etch the as-received chip and then I use it afterward in an experiment. That gives me information on what is there already in the way of nuclear tracks."

He added that the sheets of material he got from suppliers such as Landauer were marked Use This Side. "But I find no difference in the two sides. Perhaps they are afraid that the neutron activation analysis has made a difference—the effects of nitrogen being activated by the neutron beams that goods being transported are put through." They have an americium source or something of the sort, which then provides a strong field of neutrons. "I am finding that the sheets I am buying these days show a larger number of tracks than the as-received material in the old days," he added. One of the people Oriani consulted with on these matters was physicist Mel Eisner, who made pioneering observations of cold fusion heat for Phillips Petroleum Company. Was the only way to get clean sheets for detection to go to the factory and take them as they came off without walking through screening systems? At the University of Houston Eisner worked with a company that put photochromic compounds into eyeglasses. This work included making CR-39 material.

In a phone conversation on Labor Day weekend, Mel Eisner confirmed that he and Richard Oriani had discussed the issues of how to avoid contamination in optical CR-39. "We had a lengthy conversation," Eisner said. "He was inspired that I had been with the firm that supplied material for the Gran Sasso experiments. We had supplied our optical CR-39." While Eisner didn't teach Oriani how to make CR-39, they did agree it would be a good idea to not compromise experimental results utilizing CR-39 by "make it virgin and don't expose it to unknown sources of radiation. My problem was putting in the melamine material into the CR-39 in a uniform chemical way that is what we got to make an optical quality CR-39 melamine lens. I had a close relationship with my supplier in Italy who was doing the chemical work using CR-39 for emulsion work. Richard said he would try that out but I never followed up to find out." Eisner added that he believed Oriani's criticisms and concerns of CR-39 analysis in LENR work was "quite valid."

What would Eisner's recommendations be for people working in the field to safeguard against the kind of contamination that Oriani was warning about? "Shipping CR-39, I don't know," he responded. "We didn't discuss that. I don't know where he got his CR-39…I know how CR-39 develops. It was a very useful optical polymer for sure."

Did Eisner think for diagnostics CR-39 use had to be scrutinized in the way Oriani spoke of? Should researchers have to account for the problems of transporting it? Eisner responded, "How you handle it, how it is made. Like anything, the quality of CR-39, or reliability, will depend upon those things and what it is to be used for. We had a particular need for it, which is optical quality. That is, clarity, lack of scattering…in particular, being able to introduce the melamine absorbers in a uniform way, nanoparticles so to speak…We did this work at the University of Houston, then we went to a private company that made the melamine lenses. They are still on the market." Eisner adds, "I think Oriani was a very careful and interesting researcher. I looked at his work and enjoyed it."