10 Years of Confusion

This book focuses on F-P Clean Energy cold fusion. The name "cold fusion" was first applied to a room temperature fusion process now called "muon-catalyzed" fusion. Muon-catalyzed fusion produces lots of radiation. The story of the radiationless cold fusion controversy is pretty well known. See Wikipedia topics **Cold Fusion** and **Condensed Matter Nuclear Fusion**. 20 years ago two well known chemists, former master and student, had a crazy vision. They thought, "Could the separation between chemistry and nuclear physics be total?", as enshrined in scientific orthodoxy.* "Maybe the peculiar chemistry of hydrogen in palladium metal could allow a new form of nuclear fusion to occur. Maybe some strange and rejected claims from the past were real." These were two respected chemists. Professor Martin Fleischmann was a Professor at Southampton University and a Member of the Royal Society. His former student, Professor Stanley Pons, was Head of the Chemistry Department at University of Utah. Both Fleischmann and Pons (F-P) were authors of a large number of professional papers. They decided to get together and work in the lab, which is what they did during the late 1980s. And they saw some strange things. They sometimes seem to get back more heat flowing out of electrolysis cells than the energy they were adding in the form of electrical power. Was this extra heat energy the result of chemistry-induced nuclear fusion? If so, it was what they were looking for. They finally decided that their observations were valid. They announced their findings in 1989 and published their results in the *Journal of Electroanalytic Chemistry*. There was euphoria. But cooler heads said, "This can't be true". Thus began two decades of dispute, the "cold fusion" controversy which still continues.

Much has happened since that time. The world has become obsessed with global warming and the price of fuel. Societal conflict has engulfed the world's major oil producing countries. Revolutionary changes have evolved in relations between former world power contenders. Asian countries have become leaders in manufacturing and science. Mapping of genomes and identification of genes have created enormous new understandings in biology and medicine, and have led to recognition of the close kinship between the peoples of the earth. The new words in fashion are "common ancestor".

The world's rejection of cold fusion has not been universal. There have been important exceptions. Reifenschweiler published evidence that tritiated titanium powder decayed more slowly than normal radioactive tritium. His observations preceded the F-P announcement. Julian Schwinger, arguably the most profound of U.S. born theoretical physicists, resigned from the American Physical

Society when they refused to publish his thoughts on cold fusion. He subsequently

* The Fleischmann quotes in this Chapter are remembrances and interpretations of conversations between Fleischmann and the author.

published his thoughts in the German journal *Zeitschrift fur Naturforschung*. Independent research teams headed by Mel Miles and Mike McKubre identified the cold fusion nuclear product, helium gas, which was measured in the theoretical expected amounts. Yoshiaki Arata and YueChang Zhang (A-Z), a second highly competent professor and former student team, repeatedly generated fusion heat using deuterided nanopalladium metal. Nonetheless, the conflict between accepted scientific theory and F-P cold fusion continued.

The first 10 years of cold fusion research is well documented in a sequence of international conferences and their published Proceedings. The first seven meetings were held in the US, Italy, Japan, Monaco, and Canada. More recent meetings have added China, France, and Russia to the hosting countries. The conference proceedings were published under a variety of names. The world conferences have come to be referred to as the International Conferences on Cold Fusion (ICCF), with the compilation of papers listed as *Proc. ICCF1* through *Proc. ICCF13*. There are also publications in a variety of refereed Journals, like *Fusion Technolog.,* the *J. Electroanal. Chem.,* and *Japan J. of Appl. Phys.* There has also been an independent series of important conferences on the Black Sea in Russia.

The individual ICCF conferences have been exciting and historic events. The F-P observations of radiationless nuclear fusion challenged accepted physics even more than had the discovery of high temperature superconductivity, which occurred a few years earlier. The first meeting was held in Salt Lake City at a time of great excitement. The ICCF1 Proceedings starts with three papers by McKubre *et al.*, Applebee *et al.*, and Schreiber *et al*, each of which presents strong evidence of radiationless fusion heat, called excess heat. Many of the characteristics of excess heat generation, like the occurrence of multiple-hour "bursts" of heat production and a need for high D/Pd ratio were present in these introductory papers. A special conference event was an encouraging talk by Nobel Laureate Julian Schwinger. Schwinger may be the most important US-born theoretical physicist. A year later, ICCF2 took place a few miles from where physicist Volta lived on the shores of Lake Como in Italy, and not far from where Mussolini met his dismal end. A fabulous location for a meeting. The meeting was a spirited one, challenging the rejection of cold fusion by the main stream physics community. One highlight was a presentation by Liaw showing evidence for fusion heat at 460 ^{o}C, using molten salt electrolysis to plate D^- ions onto palladium metal. M. Miles and B. Bush *et al.* presented the first evidence for helium production correlated with excess heat at the calculated heat per atom ratio. The ICCF3 conference took place in port city Nagoya, where subway signs are in English as well as

Japanese. Participants were hosted by Mr. Minaru Tayoda, best known for his company's motor cars. At the reception fabulous food and drink were served on tables decorated with beautiful ice carvings. In his welcoming talk he said "Cold fusion is not a matter to be studied by a single enterprise or nation. I have confidence that it will become the greatest asset as an eventual energy for mankind, to be shared among the world". Mr. Toyoda passed away before the Proceedings were published. At the time, Mr. Toyoda was supporting research institutes in Japan and France. McKubre *et al.* and Kunimatsu *et al.* reported more quantitative data showing the necessity of high D/Pd ratio in production of excess heat, Storms showed that Pd metal had to have near-formula density for heat production, and F-P show that a major production of excess heat occurs during boil-dry events, in which all electrolyte evaporates during the heat release event. The fusion heat was calculated from the heat of vaporization of the boiled water. Discussions were animated. Proceedings Editor H. Ikegami suggested that "cold fusion" would be better called "fusion in solid state".*

The scene was very different at ICCF4, which was sponsored by the Electric Power Research Institute (EPRI) on beautiful Maui Island in Hawaii, where the temperature and rainfall changes as you drive up the gentle side of a mountain, and the ocean carves a natural bridge at the ocean's edge. Among the memorable papers was one by Gozzi *et al.* At ICCF3 Gozzi had described a beautiful test assembly involving 10 cold fusion electrolysis cells and 60 large volume neutron detectors, all individually metered so that any heat release event in one of the electrolysis cells could be checked for neutrons recorded in neighboring counters At ICCF4 he described an improved torus of electrochemical cells and neutron detectors, and presented the carefully analyzed results. Cells 2, 4, 8, and 10 produced periods of 2 to 19 W of excess heat. After thorough data analysis the conclusion was that "There was no statistical evidence of neutron emission from the cells". This is strong evidence that the cold fusion process generates no detectable neutrons. Pons and Fleischmann reported on their observation that heat continues to be generated after boil dry events for a considerable period of time after electrolysis input power has ceased. They named the phenomenon "Heat after Death". Julian Schwinger gave his final thought-provoking talk, summarizing his thoughts on cold fusion. He suggested a connection between a ^{3}He reaction and ^{5}Li decay, both of which lead to ^{4}He. Further examination of his suggestion indicates the existence of an excited state of ^{4}He near its ground state. The world's failure to support Schwinger's work will be a sad note in physics history. ICCF5, in Monaco was noteworthy as the first of the ICCF conferences at which A-Z presented their excess heat observations from nanometer Pd. Two of their run curves are included in Supplement 1.** Reifenschweiler reported on his discovery that tritium absorbed in small crystallites of titanium has reduced radioactivity. He had worked on portable neutron generators which used tritium stored in this form since 1961. His data show that imposition of lattice geometry onto tritium blocks the tritium nuclear decay process. McKubre *et al.* showed his important empirical formula that fits his team's observations of heat production in terms of measured experiment parameters: current density, D/Pd ratio, and the passage of

* Arata and Zhang posted the name Solid State Plasma Fusion ("Cold Fusion") next to the entrance door to their lab at Osaka University.
** Supplements available on request from tchubb@aol.com.

deuterium into and out of a Pd metal surface. Again the meeting location was exciting and the presentation environment great, provided one didn't lose too much money at the gaming tables.

Each succeeding conference has similarly had its share of noteworthy research results. The EXPERIMENT Section begins with ICCF6 and a visit to A-Z's laboratory at Osaka University. ICCF6 is also noteworthy for the first report of excess heat by Iwamura *et al.* using deuterium permeation through a Pd plate containing a metal oxide. EXPERIMENT will show that interfaces between an ionic oxide and nanometal will likely to play a key role in development of commercial cold fusion heaters.