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Research Article

Alternatives to Calorimetry

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Abstract

Since the first publication of Martin Fleischman and Stanley Pons in 1989, the majority of articles in the LENR field have focused on calorimetry. Many calorimetry experiments are masterpieces of science. Nevertheless, despite the experimental evidence, the results indicating excessive heat have not convinced the scientific community. For this purpose, we propose three relatively simple techniques: The "Fusion Diode" effect, the Reifenschweiler effect and a new postulated effect, not yet observed: the magnetic alignment of the tritium pairs.

Keywords: Bose–Einstein condensate, Deuterium, Direct conversion, Fusion diode, Tritium

1. Introduction

Since the first publication of Martin Fleischman and Stanley Pons in 1989, the majority of articles in the LENR field have focused on calorimetry [1]. This is true for both electrolysis experiments and gaseous loading experiments [2].

Many calorimetry experiments are masterpieces of science [3]. Nevertheless, despite the experimental evidence, the results indicating excessive heat have not convinced the scientific community. Well-designed calorimetry experiments take a very long time to be developed. It's an issue, because it would be good to test many alloys systematically. It is likely that there are still unknown alloys whose ability to generate what Dr. Ed Storms calls a "Nuclear Active Environment" [4] is greater than that of palladium. It is certain that low concentrations of elements such as lithium, boron, beryllium in these alloys will have undoubtedly positive effects. We need fast and reproducible tests to sort all these alloys and select the most promising samples. Several authors have suggested that the quantum condensation of deuterium nuclei is at the root of the appearance of "NAE" [6–9]. It would be very useful to provide irrefutable proof of the existence of these quantum phases. But on top of that, these quantum phases could provide a relatively easy way to sort out the most useful alloys for LENRs.

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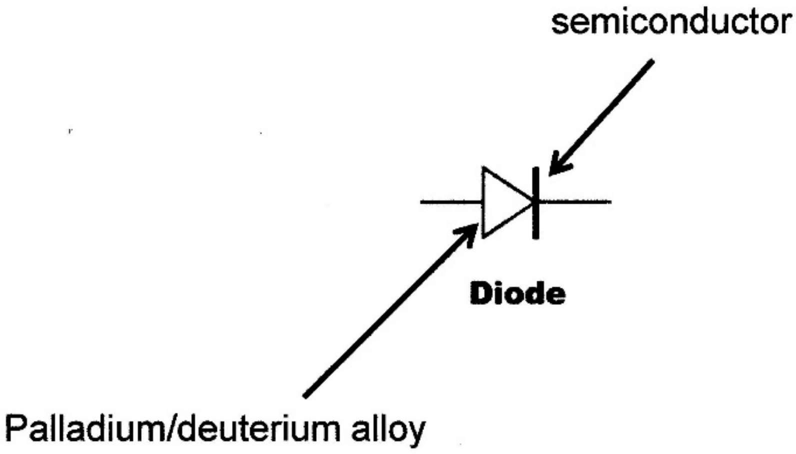

Figure 1. Fusion diode.

For this purpose, we propose three relatively simple techniques:

(1) The "Fusion Diode" effect: deuterated alloys in contact with a semiconductor cause the appearance of an easy-to-measure electrical voltage. If this voltage is actually due to the direct conversion of LENR, we have a simple method to select the most promising alloys (Fig. 1).
(2) The Reifenschweiler effect: the variation of tritium beta-rays bremsstrahlung conversion efficiency as a function of temperature is also a simple method for sorting the most efficient alloys [10].
(3) The magnetic alignment of the tritium pairs: this effect, which we have postulated, but not yet observed, would make it possible to very quickly test many new alloys [11].

In this article, we want to discuss how it is possible to find alternatives to calorimetric experiments.

2. The Fusion Diode Effect

It is very difficult to make good calorimetric recordings. It is easier to count X-rays. But the easiest way to get a scientific evidence about any kind of phenomena is to do electrical recording. We have suggested the idea of "Fusion Diodes". Fusion diodes are made of a palladium (or other alloys) in close contact with a semiconductor. This is a semiconducting diode.

When fusion reactions take place near the metal/semiconductor contact, at the beginning we had high energy quanta (in the MeV range), and then thermalization occurs, leading to Anomalous Heat Effect (down-conversion of Hagelstein). But before thermalization, the decaying energy match the level of excitation of the electrons of the metal: some energy is transmitted to the electrons before thermalization (like in a photovoltaic cell, but in our diodes, the energy source is expected to be the fusion of deuterium, protium, or perhaps lithium, boron, or beryllium).

At the contact between metal hydride and metal, pairs of electrons and holes are created, and depending to the height of the potential barrier between the two material, a voltage is created (and also an electrical current, of course).

We can record the voltage and the intensity of the resulting current at the positive and negative side of the diode. This simple device allows a simple recording of the total output power, because there is no electrical input. We plan to record this electrical energy during months or even years, to exclude the possibility of a chemical origin. It is important to note that these devices have no electrical input. There is also no thermal input. The energy is released as electrical current, and this is very easy to record with high accuracy. We are using diodes made of palladium as the metal, and silicon as the semiconductor. We have also tried other semiconductors like aluminum nitride and organic semiconducting ink. But we only published our experiments with silicon. The palladium is loaded with deuterium simply by the gas-loading method. We do not know the effective loading value, but it is probably rather high, because of the micrometer size of the palladium powder. A diode is basically a surface of contact with a metal (electronic conductor) and a semiconductor (hole conductor).

We think that the deuterium nuclei which are in the palladium will be driven in the direction of the electric field. Once these deuterium nuclei will arrive at the interface between palladium and the semiconductor, they will accumulate there. The probability of fusion probably will increase [4].

Better: if reactions of cold nuclear transmutation take place into the junction, an excitation of the electrons will occur at this place (as in the junction zone of a photovoltaic cell). A solar cell is a nothing than a flat diode with a large surface. When photons fall on the junction zone, some atoms are excited, and electrons pass from a low energy level to a higher energy level. A spontaneous electric voltage thus will appear. It is what we observed. In our diodes, the nuclear energy is transmitted to the electrons before thermalization.

In order to get a surface of junction as large as possible, our fusion diodes are made as powder diodes, with a large surface junction made up of a semiconductor powder in contact with palladium powder charged with deuterium [5]. The weight of palladium powder is comprised between 1 and 2 g by diode. This energy very quickly appears as a spontaneous potential difference which can reach over 0.5 V/junction (open circuit) (Fig. 2).

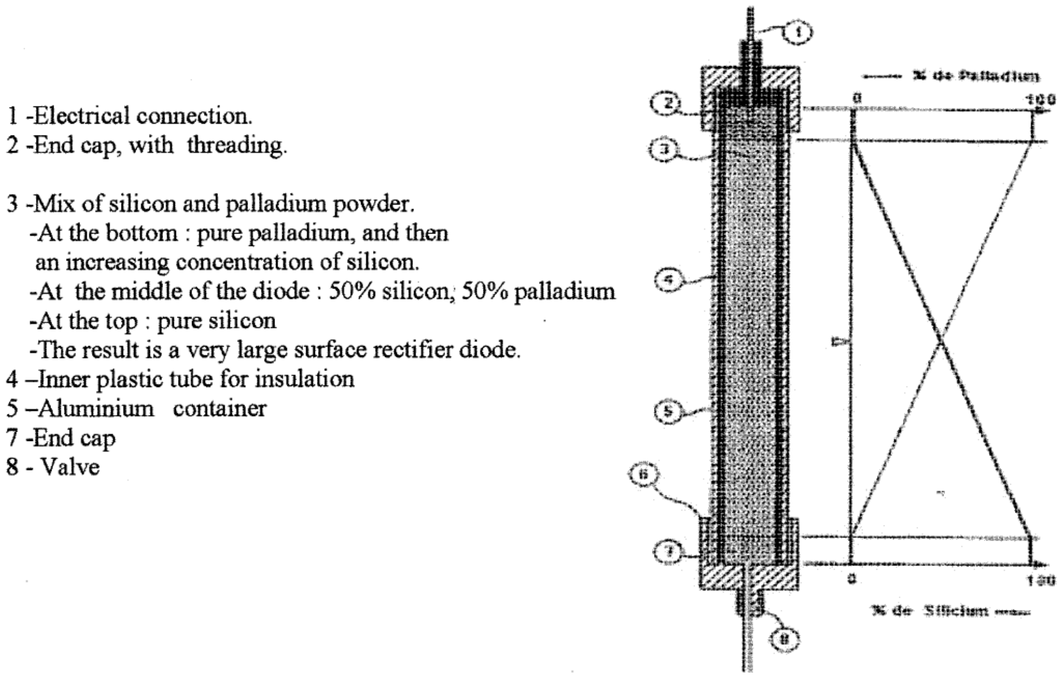

Figure 2. Powder fusion diode (length: 14 cm, diameter: 1.6 cm).

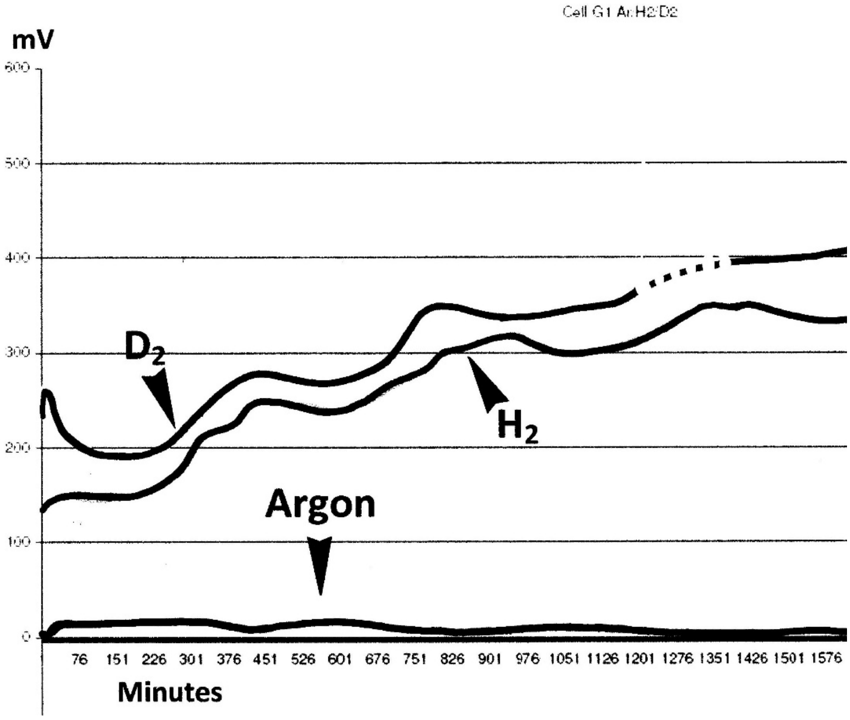

Figure 3. Voltage recording at the ends of a fusion diode.

Diodes comprising of a stack of junctions were made, making it possible to obtain over 1 V at the poles of a very compact device of a few centimeters' length. The released power remains very low for the moment, (in the nanowatt range) but it should be noted that it is presented in the form of directly usable electrical energy, and not of thermal energy (Fig. 3).

Of course, we have made blank and control experiments. We have built three diodes each time, one filed with pure deuterium (1.5 bar) another filed with hydrogen at the same pressure, and another filled with pure argon. We observed no voltage with argon filling, a little voltage with hydrogen, twice the voltage with deuterium. We think that the observed voltage with hydrogen is generated by the little amount of deuterium in the hydrogen (0.015% of deuterium in natural hydrogen). But it is difficult to avoid the deuterium leak, and the ensuing voltage drop. We plan to seal a diode in a glass tube, and measure the energy produced for several months.

Thus, it will be possible to determine whether the energy observed is actually of nuclear origin, or if it is an artefact of electrochemical origin. After several months, it will be sufficient to weigh the copper deposited on a cathode (a tiny wire of copper) whose weight is known at the beginning of the experiment to prove that the energy produced is of nuclear origin (or not…).

Of course, it is rather tedious to work with powders. But the "Fusion Diode" effect is highly reproducible, even with thin films of organic semiconductors. The authors used many different embodiments of the "Fusion Diode". Another team working on "fusion diodes" has made diodes by vacuum metallizing silicon wafers. On one side is deposited a palladium film, and on the other a gold film (forthcoming publication).

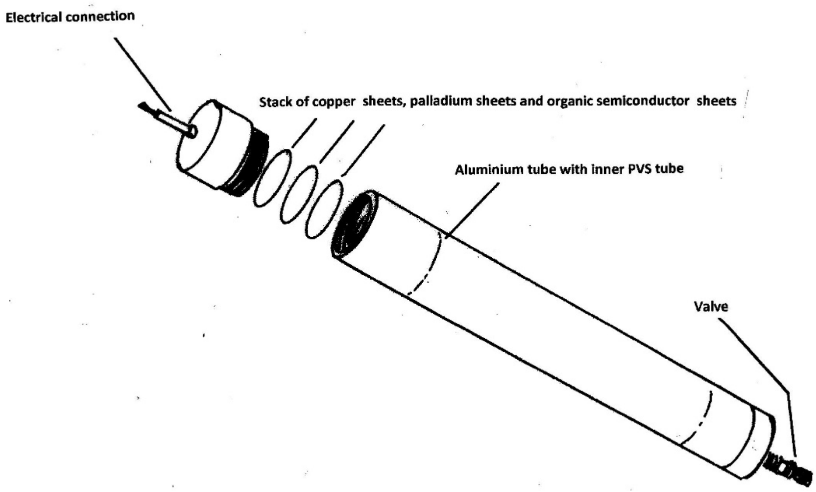

Figure 4. Stack of fusion diodes (please read "PVC" instead of the wrong acronym "PVS").

We used sheets of aluminum foil covered on one side by a thin sheet of palladium, and on the other by a layer of semiconducting paint (Plexcore® Organic Conductive Ink, Sigma). Little disks are then cut with a punch and these disks are stacked on top of one another and compressed with a hydraulic press. A valve makes it possible to pressurize the container with deuterium (Fig. 4).

A better method would be to use a plastic semiconductor film covered with a palladium sheet on one side, and a gold leaf on the other side. Whether in the form of metal powders or thin metal foils, it is possible to quickly test a large number of alloys containing deuterium or hydrogen. The higher the voltage, the better the LENR properties of the tested alloy. A large number of new alloys have been developed over the last 20 years by the metal-hydride battery industry, and also for the storage of hydrogen. Many of these alloys are available in the supplier's catalogs (Sigma–Aldrich). These alloys are much cheaper than palladium, and their price will drop considerably as soon as they are produced in industrial quantities. Nickel alloys look promising [2].

By way of example, the properties of the ZrV2 H5.5 alloy are better than those of pure palladium (3% weight of hydrogen versus 0.5% for PdH0.6 and equivalent pressure at 300 K of 10^{-8} bar versus 0.02 bar for palladium) (Ref: D. Chandra et al., Material Matters, Vol 6, no. 2, Sigma–Aldrich eds., 2010).

3. The Use of the Reifenschweiler Effect

The Dr. Otto Reifenschweiller was heading the neutrons generators department of PHILIPS during the 1960s. In 1964, Reifenschweiler noticed that the *apparent* beta-decay of the tritium absorbed into titanium changes with the temperature of the titanium. Reifenschweiler has waited his retirement to publish his observations [10]. Here is the curve obtained by Reifenschweiller: the apparent radioactivity of tritium decreases by 40% (Fig. 5).

In our opinion, the number of disintegrations per second does not change, it is just the yield of counting X-rays produced by bremsstrahlung that varies. We believe that at low temperatures, the tritium nuclei contained in the metal combine two by two to form composite bosons (two tritium nuclei of opposite spin form a composite boson, such as helium-3 nuclei in superfluid helium-3). The tritium nuclei have a spin of 1/2. They are therefore fermions. In superconductors, the electrons combine two by two to form composite bosons of spin 0 (the two electrons of each pair

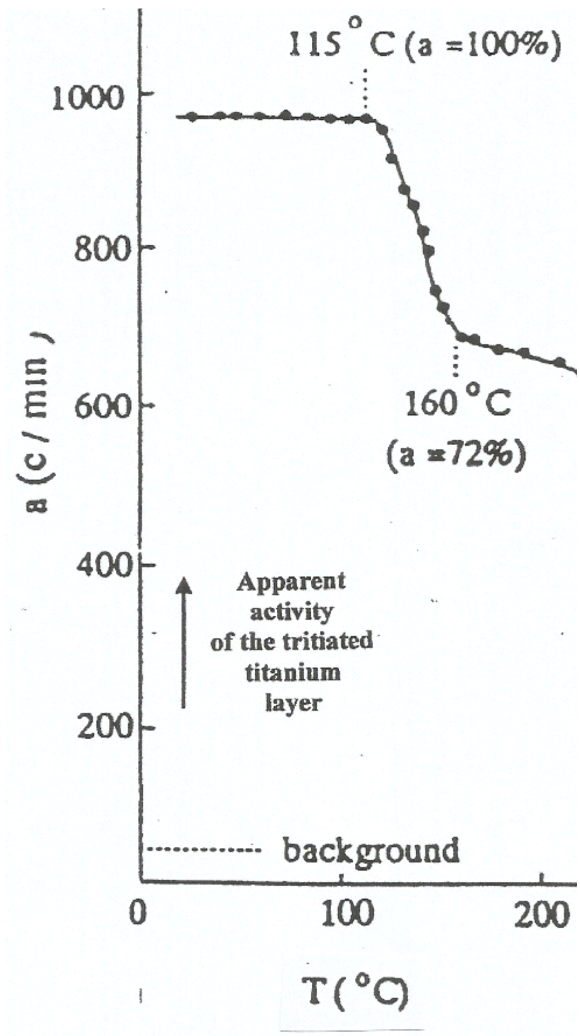

Figure 5. Decrease of the (apparent) radioactivity of tritium as a function of temperature.

are of opposite spin 1/2). These composite bosons can form a superconducting quantum phase. We hypothesize that tritium nuclei can also associate two by two to form composite spin-zero bosons.

These composite bosons can therefore form a Bose–Einstein Condensate (we will not discuss here the physical phenomena that make possible the existence of a BEC at room temperature) [11,12]. In this case, during the beta decay of a triton in this BEC, there is no more recoil of the nucleus: the energy of beta rays and neutrinos increases. The whole spectrum of beta electrons is shifted slightly towards high energies, and the counting efficiency increases. As the temperature increases, the pairs of tritium nuclei break and the Bose–Einstein Condensate disappears, and thus the counting efficiency of the radioactivity decreases.

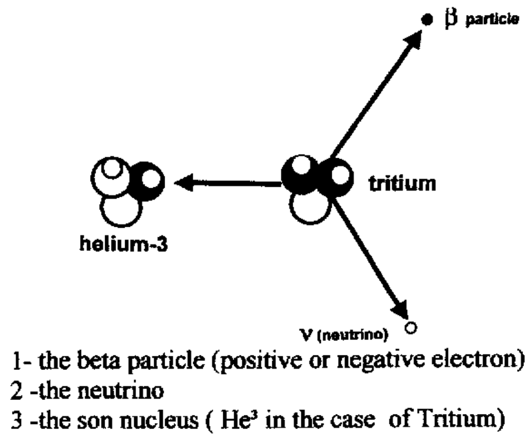

Figure 6. Balance of beta-decay energy.

The decay energy of tritium is divided into three parts: the electron energy, the neutrino energy, and the recoil energy of the helium-3 nucleus (Fig. 6). We hypothesize that when the tritium nuclei are engaged in a BEC, it is the whole BEC that absorbs the recoil energy. As a result, there is very little energy transmitted to the BEC, and therefore,

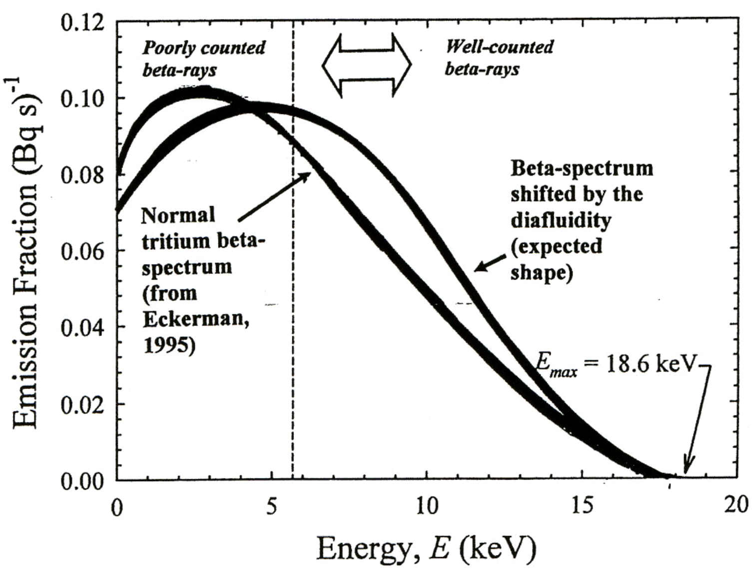

Figure 7. Spectrum of normal tritium decay and expected BEC tritium decay spectrum.

correlatively, there is more energy carried by the neutrino and the beta electron. The spectrum of the beta rays is thus shifted to the "high" energies (Fig. 7). If the BEC is suppressed by the rise of the temperature, in the opposite way, the spectrum is moved towards the low energies. This effect is extremely weak. But by chance, we have a natural amplifier that helps us to highlight it. Indeed, in the Reifenschweiler experiments, the conversion of beta rays into X-rays by bremsstrahlung is used. This effect is mainly caused by the upper part of the energy spectrum of tritium (low energy X-rays do not come out of the experimental setup, nor do they enter the Geiger counter, so they are not counted). A small shift to high energy will therefore have a relatively large effect.

This phenomenon is very important for our field of research because many authors have asserted that the "Nuclear Active Environment" that allows the LENRs is due to the formation of Bose–Einstein Condensates [4–7].

It is therefore possible to use the Reifenschweiller effect to sort the new alloys containing hydrogen according to their capacity to house BECs. (Of course, we will use a simpler experimental device than that of Reifenschweiler: small sealed ampoules glass containing the alloy powder and tritium, and a small programmable oven.) It is probably possible to design experimental devices even simpler, and bringing even more convincing results.

4. The Magnetic Alignment of the Tritium Pairs

This effect, which we have postulated, but not yet observed, would make it possible to very quickly test many new hybrid-forming alloys. We propose to make sealed glass sources containing alloy powder and tritium. These sources will be placed in the gap of a powerful electromagnet. When the electromagnet will be turned on, the spins of the tritium nuclei will align with the magnetic field and the composite bosons will be destroyed. The condensate of Bose–Einstein will disappear. The beta spectrum will be shifted slightly towards the low energies and the counting efficiency of the radioactivity will decrease.

If it exists, this new effect will be easy to prove and it can be very useful to sort the best NAE alloys, regardless of the theoretical importance of this effect.

5. Conclusion

Despite the quality of the experimental results proving the reality of the Fleischman–Pons effect (excess heat in palladium and deuterium alloys), the majority of scientists are still not convinced of the existence of LENRs. We believe that the three phenomena of the "Fusion Diode" effect, the Reifenschweiler effect, and the magnetic suppression of the triton's pairs, if confirmed, could be the basis for new techniques to confirm the calorimetry experiments. It would also be possible to use these effects to quickly select new alloys that can be used to produce LENRs.

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