Evidence of Neutron Burst in Vanadium-Deuterium System

More Evidence of Cold Fusion Catalyzed by Low-Energy Neutrons

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Abstract

Experimental results of neutron bursts from vanadium deuteride ($VD_{1.2}$) are analyzed in the Trapped Neutron Catalyzed Model for Cold Fusion (TNCF). It is shown that the experimental result is an indicator of the specific behavior of the low-energy neutrons in solids occluding deuterons.

1. Introduction

It is now decisively recognized that neutron bursts are generated in deuterides of palladium and titanium [1–5], satisfying some specific conditions clarified in cold fusion (CF) research.

On the other hand, an interesting observation of neutron bursts from vanadium deuterides ($VD_{1.2}$) was reported [6] in a document published in Russia. In this experiment, deuterium was fed by gaseous contact, and the generated neutron was measured in thermal cycles between 300° and 673° K. The distribution of the number of pulses in 300 s in the background experiment (Fig. 1) and that of the number of bursts in the same time interval (300 s) observed in the foreground experiment (Fig. 2) were compared. The total number of neutrons in burst in 300 s was $3 \times 10^3 \sim 3 \times 10^6$ when the number of the background neutron pulse was 0.074×300 (i.e., the number of neutrons in bursts is $10–10^4$ per second or $1.5 \times 10^2 \sim 1.5 \times 10^5$ per background neutron).

Two distributions with the maxima at 21 pulses and at 22 bursts respectively coincide very well each other as seen in Figs. 1 and 2.

In this paper, we will investigate this data in the TNCF model and show that the data demonstrates a role of low-energy neutrons in CF.

2. The Cold Fusion Phenomenon and Neutron Bursts

The indices of the cold fusion phenomenon are excess heat and nuclear products. Among the nuclear products, neutrons and tritium have been observed most often. There are two features in the generation of neutrons; one is the neutron burst occurring intermittently and including a lot of neutrons in a short time, at most 10^8 per second, and the other is stationary neutron generation.

Stationary neutron generation gives few neutrons in a short time but gives a large number, as a whole, in a long period. On the other hand, the neutron burst gives 10^6 to 10^8 neutrons in a burst last-

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ing at most a few seconds.

Though the cause of the Cold Fusion is not well understood at present, there is much experimental data showing the role of thermal neutrons in producing neutron emission from CF materials made of Pd and Ti deuterides [7~10]. The experimental data in $VD_{1.2}$ cited above is other data of similar nature showing a close statistical relation between the background neutron pulse and the neutron burst in deuterides.

A typical characteristic of the data in $VD_{1.2}$ shown in Figs. 1 and 2 is the identity in the distribution of frequencies of events in the background (the neutron pulse) and in the foreground (the neutron burst). This correlation shows statistically that the burst in the foreground is induced by the neutron pulse in the background.

On the other hand, the neutron pulses observed in Pd/D and Ti/D systems have no such character; they have occurred very rarely [2,4] or by some excitation from outside [1].

An explanation of the CF phenomenon, including the neutron burst, has been given by us [11,12] on the bases of experimental results [7–10] and on an assumption of the existence of trapped neutrons (TNCF). In the model, the missing factor not noticed before the recognition of the CF phenomenon is the trapped neutron in the deuterides.

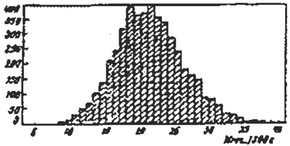

Fig. 1. Background experiment: Abscissa—Event (number of neutron pulses in 300 s); Ordinate—Frequency of events. (Figure 5 of Reference 6.)

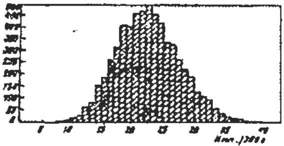

Fig. 2. Background experiment: Abscissa—Event (number of neutron pulses in 300 s); Ordinate—Frequency of events. (Figure 6 of Reference 6.)

The trapped neutron makes a fusion reaction with a deuteron (or a proton in the case of hydrides) occluded in the sample. The fusion reaction works as a trigger reaction generating a photon and a triton (or a deuteron):

$$n + p = d\ (1.33\ \text{keV}) + \gamma\ (2.22\ \text{MeV}) \qquad (1)$$

$$n + d = t\ (6.98\ \text{keV}) + \gamma\ (6.25\ \text{MeV}) \qquad (2)$$

The high-energy photon disintegrates deuterons in the material in the case of deuterides and the high-energy triton makes reactions with deuterons, breeding particles and energy successively. Those succeeding reactions (the breeding process) work to breed particles and heat and are responsible for the gigantic excess heat, the huge amount of tritium, and/or the neutron burst. Some breeding reactions in deuterides and hydrides can be listed as follows:

$$p + d = {}^3\text{He}\ (5.35\ \text{keV}) + \gamma\ (5.49\ \text{MeV}) \qquad (3)$$

$$d + d = {}^3\text{He}\ (0.82\ \text{MeV}) + n\ (2.45\ \text{MeV}) \qquad (4)$$

$$= t\ (1.01\ \text{MeV}) + p\ (3.02\ \text{MeV}) \qquad (5)$$

$$= {}^4\text{He}\ (76.0\ \text{keV}) + \gamma\ (23.8\ \text{MeV}) \qquad (6)$$

$$t + d = {}^4\text{He}\ (3.5\ \text{MeV}) + n\ (14.1\ \text{MeV}) \qquad (7)$$

$$d + {}^3\text{He} = {}^4\text{He}\ (3.67\ \text{MeV}) + p\ (14.7\ \text{MeV}) \qquad (8)$$

$$n + d = p + n' + n'' \qquad (9)$$

$$\gamma + d = p + n \qquad (10)$$

A possibility of breeding reactions had been investigated in previous papers [13,14].

The validity of the assumption of neutron trapping was verified using quantum mechanics in the regime of solid state nuclear physics [15], where a new concept of the neutron affinity of a material was proposed to specify the interaction of a trapped neutron with the lattice nuclei.

We can investigate and explain the behavior of neutron bursts observed in deuterides using the TNCF model as follows. The neutron affinity in MeV of vanadium V is negative (-3.97) in contrast to the positive values of palladium Pd (0.246) and titanium Ti (0.959). This shows that there are no trapped neutrons in the vanadium sample, and, therefore, the trigger reaction of CF events induced by the thermal neutron occurs in proportion with the number of ambient neutrons entering into the sample. This is the reason why the neutron burst in V occurred in statistical accordance with the background neutron pulse [6].

In the case of Pd and Ti deuterides, on the other hand, there could be trapped neutrons because of the positive value of the neutron affinity of the materials and the trigger reaction occurs mainly depending on the number of trapped neutrons and on the interaction of the neutron with nuclei in the material. In this case, the effect from outside can give a strong influence upon the trigger reaction and also upon the breeding reaction. Thus, the large difference in the behavior of the neutron bursts observed hitherto in Pd and Ti deuterides and in V deuteride could be understood by the TNCF model.

3. Conclusion

There are very many kinds of systems showing a CF phenomenon and also a great variety of events occurring there. To develop a science of CF, there will be several routes, from phenomenological to fundamental. In the history of the construction of the theory of superconductivity, we can see the process of development in ideas to understand the phenomenon.

The present status of the science of CF seems to be a typical stage of a science where the phenomenological approach is essential and effective. The TNCF model is an example of such a trial to understand CF phenomenon as a whole as consistently as possible from a point of view with the least assumptions.

It is also intended to keep the fundamental principles of modern physics unchanged. The qualitative reproducibility of CF phenomenon worked out recently is also consistent with the nature of the TNCF model. The trigger and breeding reactions listed above are governed by the atomic configuration in the sample which depends sensitively on the stochastic processes of the diffusion and the nuclear reaction. The lack of the quantitative reproducibility is an index of the statistical nature of the CF phenomenon.

It is possible to say that the assumptions made in the earlier stage of the TNCF model have been justified by ordinary quantum mechanics and some new features of solid state nuclear physics in materials with thermal neutrons are unfolding its veil.

Like a difficult riddle in a riddle game, the physics of CF which appeared before us seven years ago is challenging us to be solved. The hint given us through the neutron bursts will be an important clue to solve the riddle for scientists with clear eyes.

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Third Russian Conference on Cold Fusion and Nuclear Transmutation

Oct. 2–5, 1995, Sochi, Russia

Report by Hideo Kozima

Using Russian as the official language with English translation (and vice versa), the Third Russian Conference on Cold Fusion and Nuclear Transmutation (RCC-FNT3) was held on October 2 through 5, 1995, in Sochi, Russia. Attending were 38 participants (including 8 from countries outside of Confederacy of Independent States [CIS—the former Soviet Union]) and 32 presentations were given. The presentations were divided into General, 4; Theory, 10; and Experiment, 18.

The presentations were expected to be given in 40 minutes including discussion, though almost all presentations consumed a longer time (about one hour). Having enough time to ask questions and to discuss problems, participants could well understand essential points of the presentations.

The quantity and quality of experimental results presented from Russian scientists have shown that this country is one of most enthusiastic countries to explore CF in the world.

Following are informal summaries (with weight on experimental works) of papers presented at the Conference with comments and references for some reports arbitrarily chosen by the writer for the benefit of the reader.

October 2

2-0. Opening Talk—Y. Bazhutov

2-1. L. Sapogin—"One Mechanism of Energy Generation within the Unitary Quantum Theory (UQT)."

According to a theory proposed by the author himself in 1973, he explained heat generation in cold fusion phenomenon. It became clear through discussion that UQT itself has a difficulty predicting an existence of a neutrino with a mass of 20 eV, contradicting present experimental results in elementary particle physics.

cf. L. Sapogin, *Nuovo Cimento*, 53A, 251 (1979).

2-2. M. McKubre—"Condition for the Observation of Excess Power in the D/Pd System."

The same content was reported at ICCF-5 (Monaco, April 1995). The excellent experimental relation: $P_{ex} = M(T)(x-x_0)^a(i-i_0)^b\, dx/dt$ obtained and proposed by the author before was explained and discussed. Through the discussion, it became clear that the quantities in the equation, x (loading ratio D/Pd), i (electrolyzing current density) and temperature depending coefficient M(T), are not orthogonal (i.e., not independent).

It is necessary to take care of parameters of this nature when we use this experimental formula in the analysis of experimental data.

cf. M. McKubre et al., *Proc. ICCF-5*.

2-3. H. Kozima—"Neutron Bands, Neutron Cooper Pairs, and

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