On the Reduced Radioactivity of Tritium Absorbed by Titanium

Hideo Kozima
Department of Physics
Faculty of Science
Shizuoka University
836 Oya, Shizuoka 422, JAPAN

Abstract

A remarkable experimental result of reduced radioactivity of tritium absorbed by titanium observed by 0. Reifenschweiler is analyzed on TNCF model. The radioactivity measured in not discriminated in energy and is the total result of the beta from tritium and neutron in the sample. In TNCF model, trapped thermal neutron in a crystal can be affected its decay behavior by the interaction with lattice nuclei. The reduction of the radioactivity is interpreted as a result of the neutron-lattice interaction, i.e. the disappearance of the radioactivity of some neutrons in the sample in an optimum condition. The density of the trapped thermal neutron contributing to the phenomenon observed was determined as $\sim 10^{10}$ cm^{-3} in accordance with the previous data obtained in different experiments.

1. Introduction

It is a very interesting phenomenon that various strange behaviors of nuclei have been observed in some transition metals including Pd, Ti and Ni occluding hydrogen isotopes and also in some compounds containing a lot of hydrogen isotopes. The most interesting events in them is the so-called cold fusion[1,2], i.e. nuclear reactions in solids. Experimental data in the cold fusion phenomenon had been analyzed on TNCF model[3] giving a quantitative and consistent explanation of physics occurring there with the conventional physics[4–11]. It has become fairly certain that the trapped thermal neutron with densities in the range of $10^5 \sim 10^{13}$ exists stably in the sample showing the cold fusion phenomenon.

Another interesting phenomenon is the "reduced radioactivity of tritium" absorbed by titanium observed by 0. Reifenschweiler[12–14]. The theme of this paper is an analysis of this data using the TNCF model.

2. Experimental fact and its interpretation

Reifenschweiler measured the resulting X-rays induced by β-decay of 'tritium' absorbed by Ti ($TiT_{0.0035} \equiv Ti/T$ system). The sample was in a shape of extremely small monocrystalline particles with diameter ø = 15 nm. In a process of sample treatment, he observed a decrease of the radioactivity, i.e. intensity of X-rays from the sample Ti/T. From the experimental result, he had concluded the reduction of radioactivity of tritium absorbed by Ti.

We have to note, at first, that the X-rays they had measured was the result of not only the decay 'tritium but also that of thermal neutron, if any, in the sample. As we have known now, it is possible that the thermal neutron can be trapped stably or unstably in some transition metals including Ti, showing the cold fusion phenomenon if some conditions are satisfied.

In addition to the trapping, the thermal neutron could be elongated its life time due to the interaction with lattice nuclei. The trapping is a necessary condition, but not sufficient for the stability of the trapped neutron against the beta-decay or against a trapping by a lattice-nucleus.

Because of the abundant background neutrons in ambient, it is apt to measure β-decay of tritium and neutron simultaneously, no matter their origin. If the stability of the trapped thermal neutron changes, the intensity of the emitted electron from the sample, and also the resulting X-rays change. This is the most reasonable explanation of "the reduction of radioactivity of tritium absorbed by tritium" as shown quantitatively in the next section.

Knowing the change of the radioactivity from measurement, we can estimate the density of the trapped thermal neutrons in the sample as shown also in the next section.

3. Estimation of the density of the trapped thermal neutron in Ti/T system.

To analyze the experimental data observed by 0. Reifenschweiter, we will assume the experimentally observed change of the radioactivity is induced only by the change of the neutron stability, though it is possible to change the radioactivity of tritium in a crystal by an interaction with the trapped thermal neutron. Also, we will assume that the neutron density changes only through the beta decay in the time of the experiment, though it can change by the trapping of neutron from ambient. Also, it is assumed that the number of neutron changes only by β-decay throughout the experiment.

The β-decay of tritium and neutron in their free states are with decay times $T_t = 12.262$ y (= 3.87×10^4 s) and $T^0_n = 8.87 \times 10^2$ s, and the maximum electron energies 18 and 483 keV, respectively. In general, we can express the decay behavior as follows:

$$n_t(t) = n_t(0)e^{-t/Tt}, \quad \text{..........} (1)$$

$$n_n(t) = n_n(0)e^{-t/Tn}, \quad \text{..........}(2)$$

where $n_n(0)$ is the density of the trapped neutrons contributing to the change of radioactivity.

The number of events at time t per unit time and unit volume of the sample emitting an electron from tritium and neutron are given as follows:

$$N_{e1}(t) = \frac{n_t(0)}{T_t} e^{-t/T_1}, \text{.......}(3)$$

$$N_{e2}(t) = \frac{n_n(0)}{T_n} e^{-t/T_n} \text{......}(4)$$

Therefore, the number of the emitted electrons as a whole at time t in a unit time is expressed as follows:

$$N_e(t) = N_{e1}(t) + N_{e2}(t) =$$

$$\frac{n_t(0)}{T_t} e^{-t/T_1} + \frac{n_n(0)}{T_n} e^{-t/T_n} \ldots.(5)$$

As explained above, the decay time T_n of the neutron is a variable because of the neutron-lattice nuclei interaction. To analyze the experimental data, we will assume for simplicity that T_n has two values, an infinity in the stable state and 887.4 s in the free state.

Then, we have two values of the number of emitted electrons for a state where the trapped neutron is stable and another state where it decays as a free state:

$$N_e^{(2)}(t) = \frac{n_t(0)}{T_t} e^{-t/T_1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(6)$$

$$N_e^{(2)}(t) = \frac{n_t(0)}{T_t} e^{-t/T_1} + \frac{n_n(0)}{T_n^0} e^{-t/T_n^0} \ldots.(7)$$

If we consider $N_e^{(2)}$(t) is a result of only a hypothetical tritium decay, not noticing the existence of the trapped thermal neutron with a density $n_n(0) << nt(0)$, the hypothetical decay time T^*_t is given by the following relation:

$$N_e^{(2)}(t) \equiv \frac{n_t(0)}{T_t^*} e^{-t/T_1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(8)$$

$$\frac{1}{T_t^*} - \frac{1}{T_t} = 4.36x10^5 \frac{1}{t} \frac{n_n(0)}{n_t(0)} e^{-t/T_n^{(0)}} \ldots.(9)$$

Therefore, a change of the triton decay time can be detected if

$$\frac{1}{t} \frac{n_n(0)}{n_t(0)} e^{-t/T_n^{(0)}} \geq 2.3x10^{-6} \frac{(T_t - T_t^*)\min}{T_t T_t^*} ..(10)$$

Assuming an accuracy of the measurement $(T_t - T^*_t) \sim 10^{-3} T_t \sim 4 \times 10^3$ s, we obtain a condition for the number of neutrons affecting the measurement:

$$\frac{n_n(0)}{n_t(0)} \geq 10^{-16} t e^{-t/T_n^{(0)}} \ldots\ldots\ldots(11)$$

If the time t is $10T^{(0)}_n$, then

$$\frac{n_n(0)}{n_t(0)} \geq 4x10^{-18} \ldots\ldots\ldots\ldots.(12)$$

This means that a very small number of neutrons coexisting with tritium affect the apparent lifetime of the tritium determined by the experiment without the energy discrimination.

From the experimental data of $T_t - T^*_t$, we can determine the density of trapped thermal neutrons as follows. Putting $T_t - T^*_t \equiv \eta T_t$ and the time of the experiment $t = 20\ T^{(0)}_n$ arbitrarily, we obtain a relation between η, $n_n(0)$ and $n_t(0)$;

$$\frac{n_n(0)}{n_t(0)} = 1.0x10^{-9} \eta \ldots\ldots\ldots\ldots(13)$$

Taking the value $\eta = 0.4$ and $n_t(0) = 9 \times 10^{15} \mathrm{cm}^{-3}$ corresponding to the sample $TiT_{0.0035}$ from the experimental data, we obtain a value for the density of the trapped thermal neutron contributing to the measurement, i.e. emitting b-ray in a situation, but not in another, depending on the situation in the sample,

$n_n(0) \sim 3.6 \times 10^{-10} n_t(0) \sim 7.2 \times 10^9 \mathrm{cm}^{-3}$

If we take the time of the experiment t as $10\ T^{(0)}_n$ or $30\ T^{(0)}_n$, then we will have $n_n(0) = 1.6 \times 10^{14}$ or $3.2 \times 10^5 \mathrm{cm}^{-3}$.

This is the density the same order of magnitudes we have determined from the experimental data of cold fusion phenomenon on TNCF model ($10^5 \sim 10^{15}$) though there is another kind of the trapped thermal neutrons not changing their stability in the sample used in the experiment[12].

It is interesting to notice that Reifenschweiler observed a sharp decrease of "the radioactivity of tritium" when the hydrogen isotope is absorbed by small monocrystalline particles of titanium and the preparation is heated to several hundred degrees centigrade[13].

4. Conclusion

Using the TNCF model, we could understand the anomalous experimental data showing the reduction of the radioactivity of tritium absorbed by titanium. The number of the trapped thermal neutrons contributing to the reduction of radioactivity in the sample was determined as 10^{14} cm^{-3} using the experimental data. This value is in accordance with the values 10^5 to 10^{15} cm^{-3} obtained in the system showing a nuclear transmutation from Rb to Sr along with the excess heat and Pd-black/D_2O electrolysis generating a lot of helium and the excess heat.

The consistency of the interpretation of various experimental results in transition metals with positive neutron affinity[15] not only substantiates the concept itself but also makes plausible the existence of the trapped thermal neutron in those samples.

The author would like to express his thanks to Prof. K. Hasegawa of the Radiochemistry Research Laboratory for his valuable discussions regarding this work.

References

(1) M. Fleischmann, S. Pons and M. Hawkins, "Electrochemically Induced Nuclear Fusion of Deuterium," *J. Electroanal. Chem.*, **261** (1989) 301.

(2) E. Storms, "Status of 'Cold Fusion'," *Proc. ICCF5*, 1 (1995).

(3); H. Kozima, "Trapped Neutron Catalyzed Fusion of Deuterons and Protons in Inhomogeneous Solids," *Trans. Fusion Technol.*, **26**, 508 (1994).

(4) H. Kozima, K. Hiroe, M. Nomura and M. Ohta, "Analysis of the First Cold Fusion Fxperiment on TNCF Model," *J. Electroanal. Chem.* (submitted).

(5) H. Kozima, M. Nomura K. Hiroe and M. Ohta, "Analysis of Tritium and Neutron Generation in Pd+LiOD/$D_2$0 System," *Cold Fusion*, **19** (1996).

(6) H. Kozima, S. Watanabe, K. Hiroe, M. Nomura and M. Ohta, "Analysis of Data Obtained in Cold Fusion Experiment Producing Excess Power and Helium," *J. Electroanal. Chem.* (subitted).

(7) H. Kozima, K. Hiroe, M. Nomura and M. Ohta, "On the Elemental Transmutation in Biological and Chemical Systems," *Cold Fusion* **16**, 30 (1996).

(8) H. Kozima, M. Ohta, M. Nomura and K. Hiroe, "Another Evidence of Nuclear Transmutation in Cold Fusion Experiment," *Cold Fusion*, **18** (1996).

(9) H. Kozima, S. Watanabe, K. Hiroe, M. Nomura and M. Ohta, "Analysis of Excess Heat and ^{4}He Generation in Pd-black Cathode by D_2O+LiOH Electrolysis," *Proc. Jpn Acad.* (to be subitted).

(10) H. Kozima, "Excess Energy Data in D/Pd System Examined", *Cold Fusion*, **17**, 12 (1996).

(11) H. Kozima, "Analysis of Patterson Power Cell by TNCF Model," *Cold Fusion*, **17**, 8 (1996)

(12) O. ReiferischweUer, "Reduced Radioactivity of Tritium in Small Titanium Particle." *Phys. Lett. A* **184**, 149 (1994).

(13) 0. Reifenschwefler, "Some Experiments on the Decrease of the Radioactivity of Tritium Absorbed by Titanium," *Proc. ICCF5* P. 163 (1995); *Cold Fusion* **10**, T (1995)..

(14) Articles in "On Otto R.eifenschweiler's Experiments" it *Cold Fusion*, **12** T (1995).

(15) H. Kozima, "Neutron Band, Neutron Cooper Pair and Neutron Life Time in Solid", Proc. 3rd Russian Conf. on Cold Fusion and Nuclear Transmutation (*RCCFNT3*)1995, Sochi, Russia (to be published); *Cold Fusion*, **16**, 4 (1996).
