More Evidence of Nuclear Transmutation in Cold Fusion Experiments

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Abstract

Experimental data of a cold fusion experiment measuring excess heat, neutron emission and distribution of minor atoms D, Li, Si and Al in Pd cathode are analyzed on the trapped neutron catalyzed fusion (TNCF) model. A consistent explanation of the data is given, including nuclear transmutation of Al into Si by absorption of the trapped thermal neutron.

Introduction

There are many evidences of nuclear transmutation in the electrochemical[1] and the discharge[2] systems which can be interpreted as effects of the trapped thermal neutron[3]. The effect of the trapped thermal neutron was also recognized in the generation of excess heat and helium in Pd/D + LiOD system[4,5] and in experiments[6,7] where measured the excess heat.

Other experiments[8,9] showing excess heat and neutron generation together with changes in distributions of minor elements in the cathode were analyzed on TNCF model giving consistent interpretation of a whole data obtained in a series of experiments[8] including the recent one[9].

Outline of the experimental results

In an experiment[9] in the series of elaborate works[8] on Pd/D + LiOD system conducted hitherto, distributions of Pd, D, Li, Al and Si atoms in the Pd cathode were determined. Several data out of them are reproduced in this paper as Fig. 1 from the original paper[9]. The figure caption in Fig. 1 is original. We have to be careful about the normalization by the secondary ion intensity of Pd which was used to draw the curves in each figure.

As we can see in these figures in Fig. 1, densities of those elements changed drastically at near surface region of a width ~ 1μm only when the excess power and/or the neutron was detected.

The profiles of the distributions of those impurities were sensitively dependent on the situations where either the excess heat and/or the neutron was generated. When the neutron was generated together with the excess heat, the change of the profiles near the surface was large.

It was also noticed by the authors

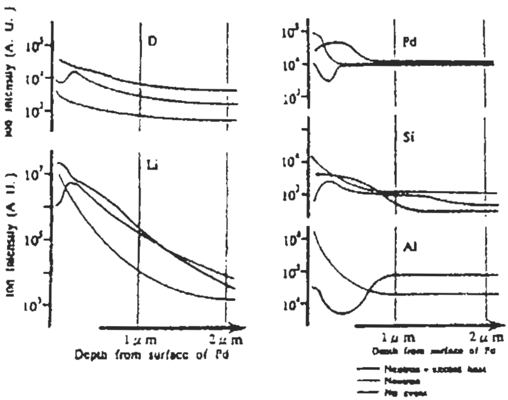

Fig.1. Examples of depth profiles for each element

that the emission of neutron with energy 2.4 ~ 5 MeV had negative correlation with the generation of the excess power of about 20% of input power, i.e. the two events had not occurred simultaneously.

From these data, we can deduce some conclusions about physics of cold fusion in Pd/D system: (1) The lithium atom had localized near the surface of Pd cathode in 1 ~ 2μm, (2). There was a depletion region of aluminum atoms at the surface with a thickness of 1μm when the cold fusion (the excess power and neutron emission) occurred, (3) There was a surplus region of silicon atoms at the surface with a similar thickness as the depletion region of Al in the same situation.

First, let's analyze these experimental data on TNCF (trapped neutron catalyzed fusion) model which was so successful in the analyses of several cold fusion experiments[3-7] given before. Here are the relevant fundamental equations:

$$n + {}^{6}Li = {}^{4}He(2.1MeV) + t(2.7MeV) \ldots\ldots\ldots\ldots (1)$$

$$n + {}^{7}Li = {}^{8}Li = {}^{8}Be + e^{-}(13MeV) + \overline{\nu}_e \ldots\ldots\ldots\ldots (2)$$

$${}^{8}Be = {}^{4}He(1.6MeV) + {}^{4}He(1.6MeV) \ldots\ldots\ldots\ldots (3)$$

$$n + {}^{7}Li = {}^{4}He + t + n + Q \ldots\ldots\ldots\ldots (4)$$

$$n + {}^{27}Al = {}^{28}AL = {}^{28}Si + e^{-} + \overline{\nu}_e \ldots\ldots\ldots\ldots (5)$$

$$t + d = {}^{4}He(3.5MeV) + n(14.1MeV) \ldots\ldots\ldots\ldots (6)$$

$$n(14.1MeV) + d = n' + p + n'' \ldots\ldots\ldots\ldots (7)$$

$$n(14.1MeV) + d = n' + d' \ldots\ldots\ldots\ldots (8)$$

In the reaction (4) induced effectively by a neutron with an energy E_n more than 6 MeV, the energy Q is given as $\sim E_n$ - 2.47 MeV.

We will not take into our account here a fact that helium is generated in the reactions (1)~(3) and (6) because there are no description about helium in the present experiment[9].

We may take the density of the trapped neutron in the Pd cathode as the same value 10^{13}cm^{-3}as in the case of a previous analysis[4] with similar experimental condition and result. The trapped neutron in a Bloch state is stable unless it is disturbed by a large perturbation like that the neutron suffers at the boundary with many disordered minor atoms. Then, the trapped neutron can interact with an minor atom in the boundary layer to fuse with it. In the following, we assume that the thermal neutron trapped in the cathode fuses with nuclei Pd, D, Al, and others in the surface layer.

Using the absorption cross section of ^{27}Al for the thermal neutron s_n = 0.36 barns[10], we can estimate the number of ^{27}Al atoms transmuted into ^{28}Si by the reaction (5) in unit area in time dt at an arbitrary time t in the surface layer as follows;

$$v_1 = 0.35 N_n v_n \rho_{Al} l_0 \sigma_n \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

where N_n and v_n are the density and the thermal velocity of the trapped neutron in the cathode, respectively, l_0 is the width of the surface layer where is a lot of Li atoms to hinder periodicity of the lattice potential for the neutron wave, r_{Al} is the density of aluminum in the layer, and $n = r_{Al} l_0$ is a number of Al atoms in the unit area of the surface layer at time t.. Integrating the above equation (9) from time 0 to t with an assumption of constant N_n, we obtain the number of Al atoms at time t: $n = n_0 e^{-(t/t_0)}$, where n_0 is n at time $t = 0$, and the constant t_0 is defined by a relationt_0^{-1} = 0.35 $N_n v_n s_n$.

The average speed of the thermal neutron v_n = 2.7 x 10^5 cm/s at room temperature and the assumed value of $N \sim 10^{13}$ give us t_0^{-1} = 3.4 x 10^{-6} s^{-1} and then a ratiox of the transmuted to the original Al atoms in the surface layer in the experiment of a duration of 520 h (t = 1.87 x 10^6 s);

$$\eta \equiv \frac{v_1 t}{\rho_{Al} l_0} \sim 6.5x10^{-1} \ldots\ldots\ldots\ldots\ldots (10)$$

This value is compared with the relative decrease of Al concentration (~ 80% in 1μm range) at the dip in the figure Al of Fig.1 with a good coincidence in the order of magnitude. The decrease of Al must be accompanied with the increase of Si which is clearly seen in the figure Si of Fig.1 in the surface layer. These features are remarkable only in the situation where the neutron emission and the excess heat were observed in the same sample.

This is understandable from our point of view that the large density of the trapped neutron was estimated[4] from the data where were the excess heat and helium generation in the sample.

The estimation given above shows that the changes of the concentration of elements in the surface layer of the Pd cathode is the results of nuclear transmutation induced by thermal neutrons in the cathode.

Similar estimation could be done with profiles of D, Li and Pd in Fig. 1 which we leave for future works.

One more thing we want to point out here is the negative correlation of the excess power and the neutron generation observed in the above experiment[9].

If the neutron emission is only a result of the nuclear reaction generating excess energy, the relation of the excess power and the neutron emission should be positive correlation.

On the contrary, however, if the neutron is the cause of nuclear reactions generating excess energy and/or other neutrons, the relation is not necessarily positive but could be negative correlation.

The case where the relation is a negative correlation could be explained as follows: At first, trigger reactions induced by the trapped thermal neutron (e.g. reactions (1) with a cross section ~ 1 barn[10] and (6)) generate high energy neutrons which is observed going out of the cathode regardless of the collisions with other particles.

When there are high energy neutrons (higher than 6 MeV), then the reactions (4) and (7) occur predominantly with a cross section ~ 0.35 barns and 0.1 ~ 0.2 barns[10], respectively.

Then, the situation will change by the piling up of neutrons to induce mainly the reaction (2), (3) and (5) to generate more heat and other nuclear products than neutron.

Conclusion

The stable existence of trapped thermal neutron in the cathode is verified qualitatively in the previous paper[11]. If we assume it, we can understand the whole experimental résults obtained in the cold fusion experiments consistently as shown above and in our previous papers[3-7]. This is reversely the manifestation of the validity of the assumption that the trapped neutron exists stably in some crystals, from our point of view. The investigation given above shows that the experimental data obtained with techniques of professional nuclear scientists is again interpreted consistently with other data[3-7].

This result is another proof of the reality of the cold fusion phenomenon without doubt and shows also the effectiveness of the TNCF model.

We will continue analyses of experimental data obtained hitherto with the same technique using TNCF model to show more clearly the reality of cold fusion phenomenon and the ability of the above-mentioned concept.

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