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MATERIAL CONDITIONS TO REPLICATE THE GENERATION OF EXCESS ENERGY AND THE EMISSION OF EXCESS NEUTRONS

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Abstract

The key parameters for occurrence of the anomalous phenomena, especially excess heat generation and emission of excess neutrons, have been investigated through a series of electrolytic experiments in Pd-LiOD(H) systems. Seven key parameters are identified. In the present work, a series of systematic experiments has been carried out with some parameters fixed. By controlling the key parameters completely, the anomalous phenomena with appreciable correlation between the excess heat generation and the excess neutron emission can be replicated successfully.

Introduction

The reproducibility of the anomalous phenomena, especially the excess heat generation and the emission of the excess neutrons, was reported [1,2,3,4], where we insisted that complete control of the 7 key parameters occurred in Pd-LiOD electrolysis was essential to attain it. The 7 key parameters have been selected as follows:

1. Purity of Pd cathode
2. Shape and size of Pd cathode
3. Processes of pretreatment of Pd cathode
4. Electrolysis mode
5. Electrolyte
6. Purity of the medium
7. Initial Open-Circuit Voltage

In the present work, the coincidental electrolysis operation of the foreground runs with the heavy water and the background (control) runs with light water are carried out under the same controlled conditions except for the electrode, LiOD(H), to realize the correlation between the excess heat generation and the excess neutrons. The depth profiles of the hydrogen isotopes are also analyzed with Elastic Resonance Detection Analysis (ERDA).

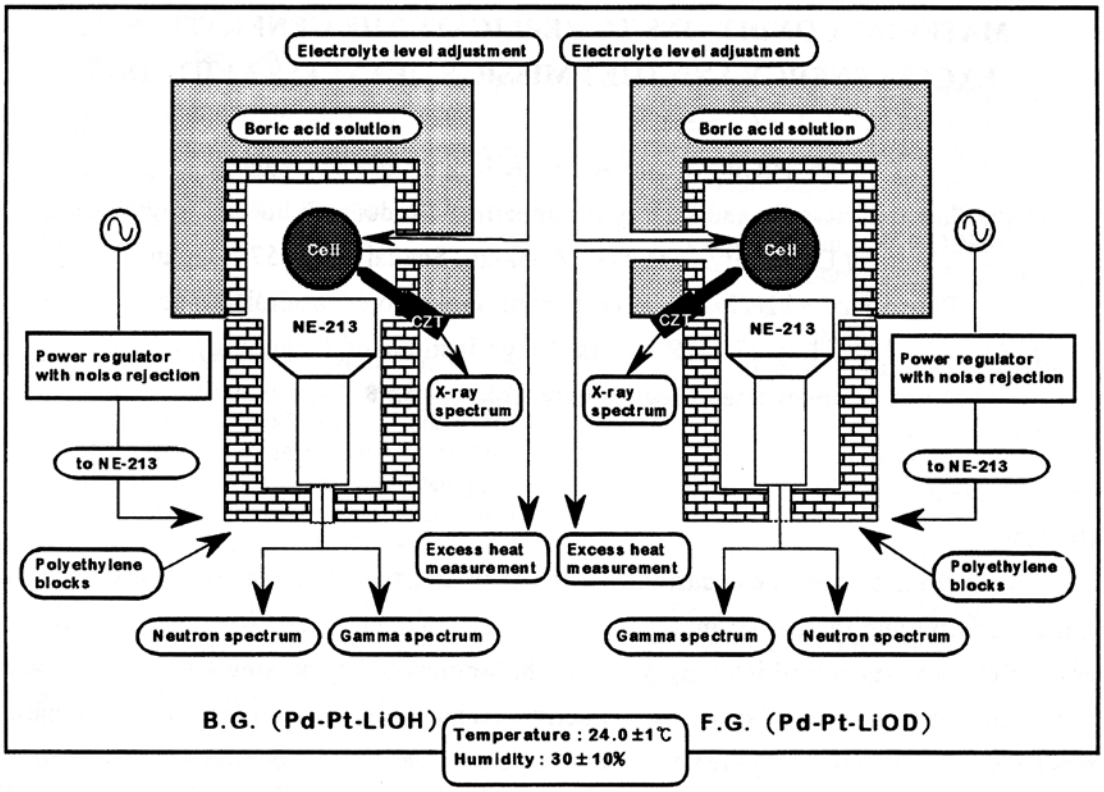

Figure 1. Coincident operation system

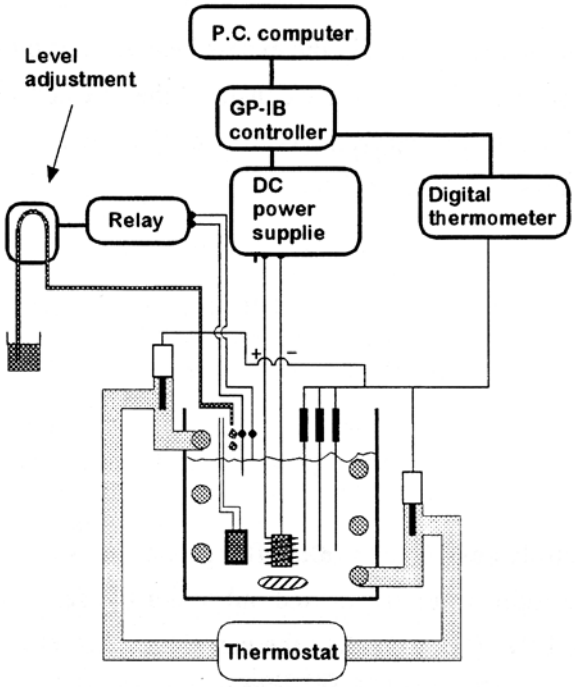

Figure 2. Schematic view of the electrolysis cell and the electrolysis control and data acquisition system

Experimental

The coincident operating system is illustrated in Fig. 1, which is the same system reported in our previous paper [1]. The preparation of the NE-213 systems are also the same. The ambient temperature is controlled at 24 ± 1°C by the two air conditioners. Fig.2 shows the schematic view of the electrolysis cell and the electrolysis control and data acquisition system. The temperature of the cooling water is kept at 24±0.1°C. The level of the electrolyte is kept constant by the level adjustment equipment. The experimental conditions are displayed in Table 1. The 4N Pd cathodes that are manufactured by Tanaka Kikinzoku Co. Ltd., are used. All the Pd samples are pretreated by mechanical polish and annealed at 850°C for 10 hours in vacua. The light water and heavy water are distilled with potassium permanganate, a strong oxidation reagent. The concentration of the electrolyte is 1 .OM LiOD or LiOH. Pulse mode electrolysis is performed with 3 hours repetition time. Current density of the high mode is 800mA/cm^2 and the low mode is 20mA/cm^2, respectively. Electrolysis experiments are operated for five weeks or more. Excess power evaluation is performed by means of inner standard calibration method reported in our previous paper [1]. Neutron emission is evaluated by calculating the neutron ratios between the neutron counting rates in the background (control) run and those in the foreground run.

Run No.	Electrolyte	Period	Cathode	Electrolysis mode
3	Foreground run → 1.0M LiOD	6 weeks	Pd plate 0.8×10×25 [mm]	Pulse mode High / Low 800 / 20 [mAcm^{-2}] 3 / 3 [hours]
4		5 weeks		
5	Background run → 1.0M LiOH	5 weeks		

Table 1. Experimental Conditions

Results and discussion

Excess power and excess neutrons

Figures 3, 4 and 5 show the neutron ratio and the excess power in each week of Run 3, Run 4 and Run 5, respectively. The physical definition of the excess heat generated and the excess neutrons emitted are as same as those used in our series of the previous papers. [1,2] The generated excess power are demonstrated by the histogram of the lower side of Fig. 3, 4 and 5. As has been reported, these two anomalous effects could not be confirmed by evidence in all the background runs in Run 3, 4 and 5. These two parameters are depicted in each one week of operation for each foreground run. Evidently from these figures, the appreciable correlation between two these anomalous effect can be confirmed in time sequences and also in its magnitude.

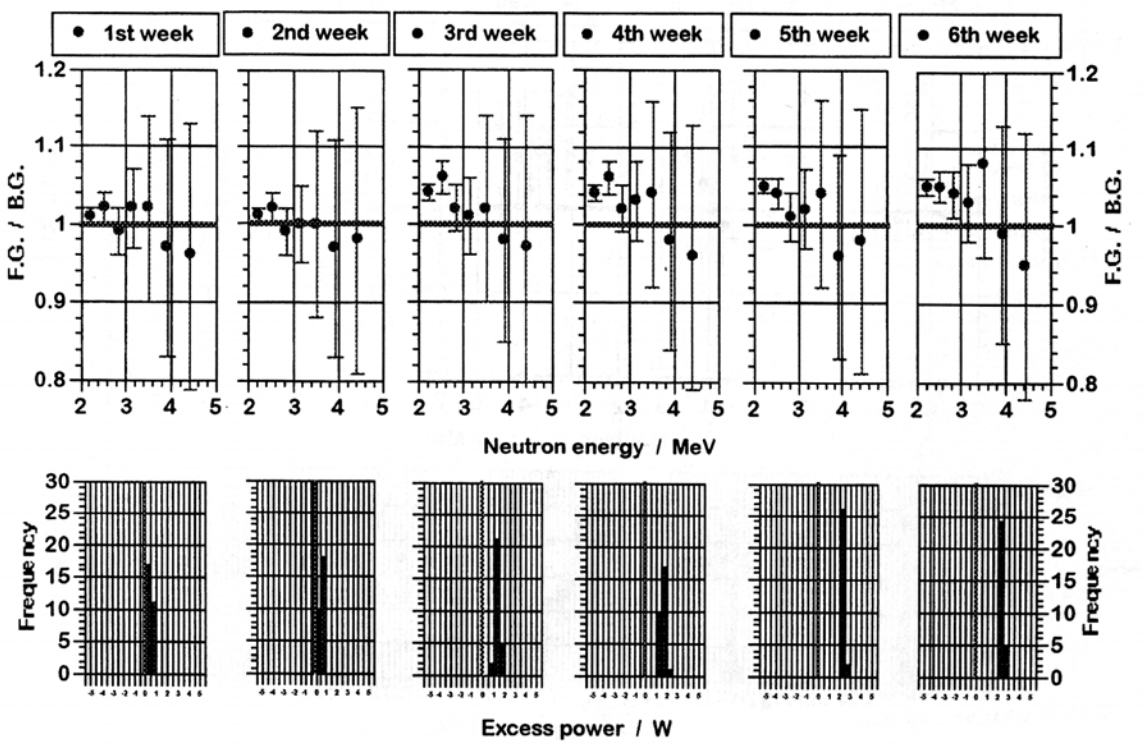

Figure 3. Neutron ratio and excess power in each week of Run 3

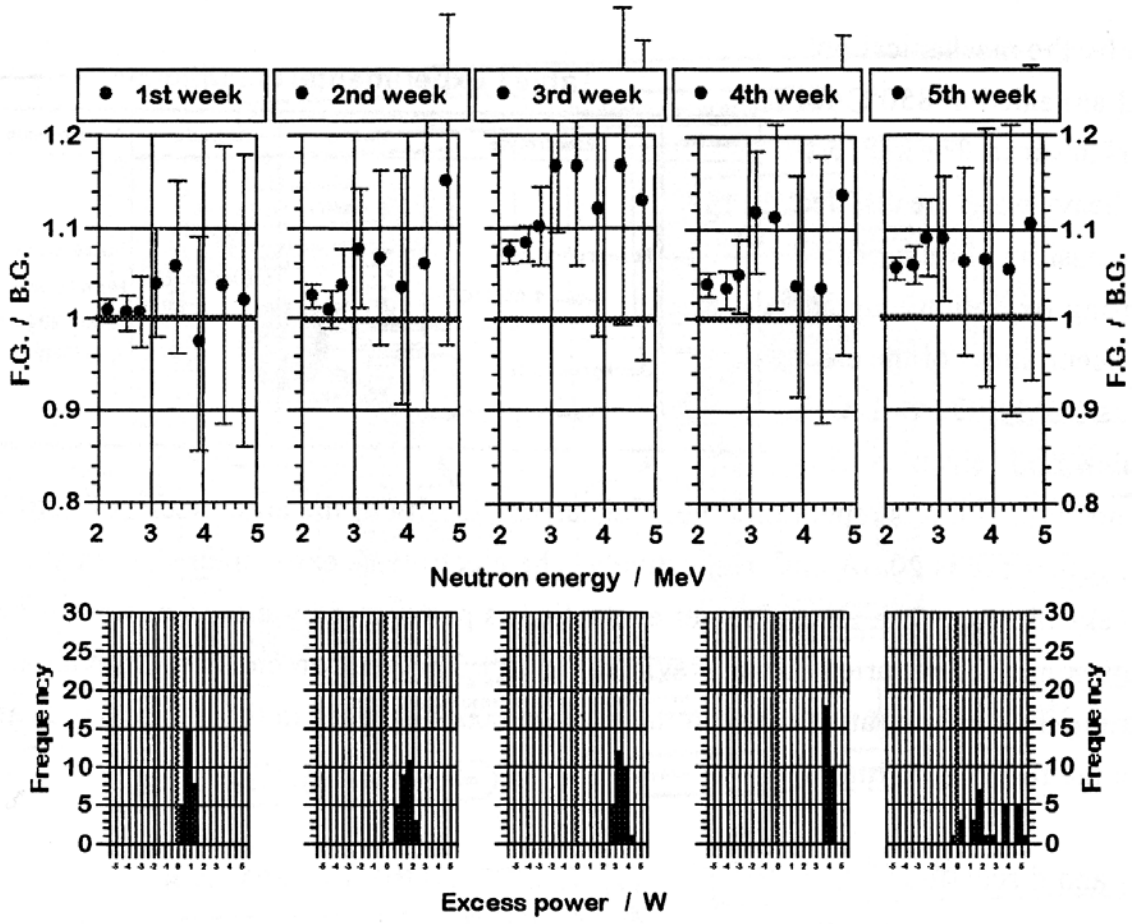

Figure 4. Neutron ratio and excess power in each week of Run 4

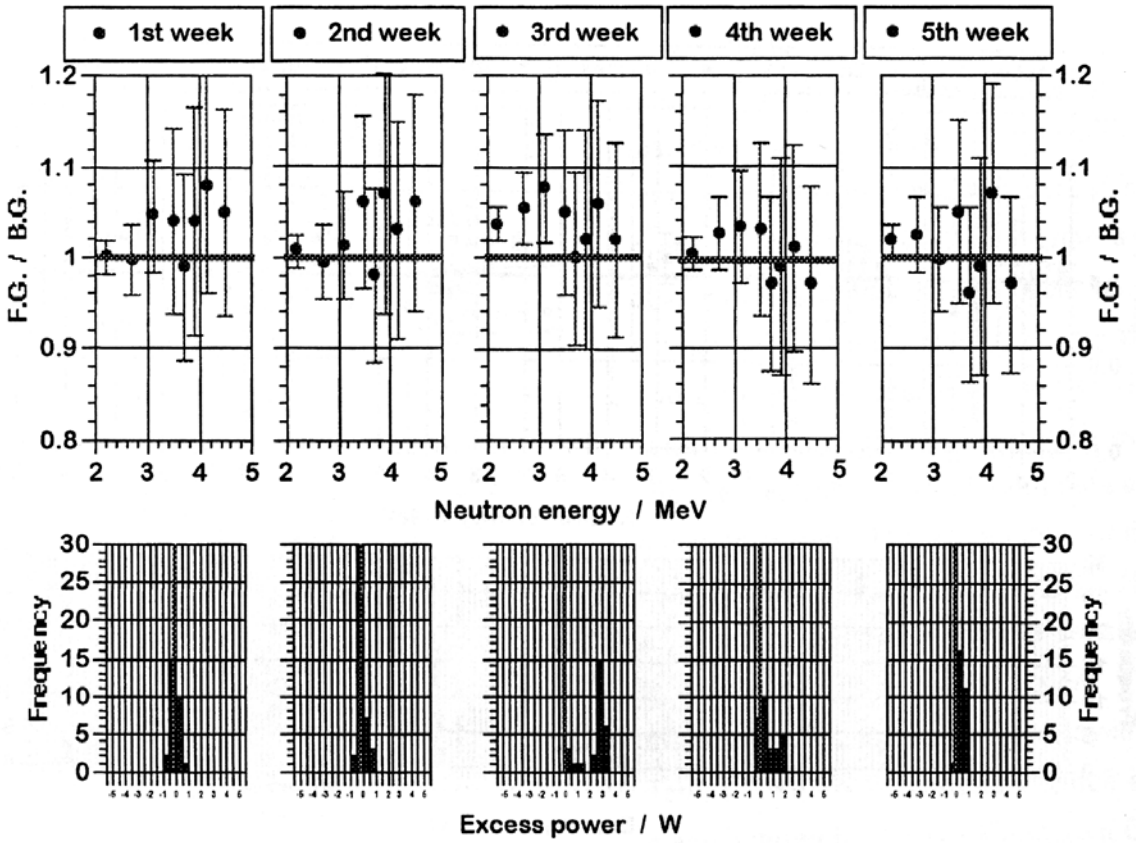

Figure 5. Neutron ratio and excess power in each week of Run 5

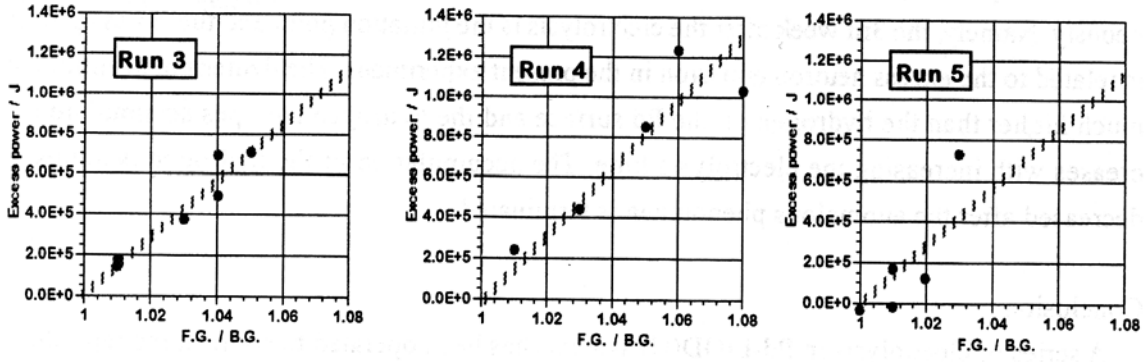

Figure 6. Correlation between the excess power and the neutron ratio

In Fig. 6, the correlation between the excess power and the neutron ratios are displayed to clarify this very important correlation. Very clear correlations are found in Run 3 and Run 4, and similar correlation in Run 5. The correlation coefficient is estimated to be about 1.5 X 10^7J/neutron ratio and this coefficient was almost constant in the present study.

Depth Profile Analysis

The typical depth profiles of Run 3 and Run 4 obtained by ERDA analysis are shown in Fig.7 and Fig. 8 for the foreground run and the background (control) run, respectively. The loading ratio reported in our previous paper [5] is almost 0.9 which is determined by the electroresistance measurement. A remarkable fact depicted in Fig.7 is that the deuterium loading ratio on the Pd surface in the foreground run exceeds the magnitude of 1.5. The hydrogen loading ratio is only 0.8 and the hydrogen isotopes loading ratio of the short time experiment is almost 1[5]. It is now obvious that much more deuterium than hydrogen accumulates on the Pd surface by continuing the electrolysis for about one month.

These experimental facts indicate that all the anomalous phenomena take place simultaneously. Namely, the third week after the electrolysis is the initiation point and the excess power is related to the excess neutron emission in the present experiment. Deuterium accumulation is much higher than the hydrogen on the Pd surface and the hydrogen isotope accumulation increases with increasing the electrolysis time. The accumulation of the hydrogen isotopes is decreased after the anomalous phenomena are terminated.

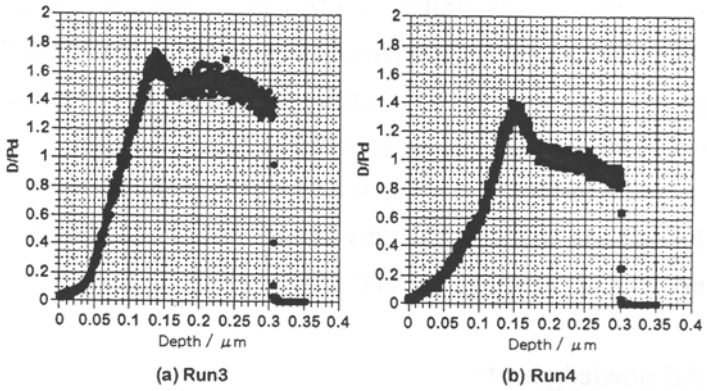

Figure 7. The depth profile of the loading ratio in the foreground run

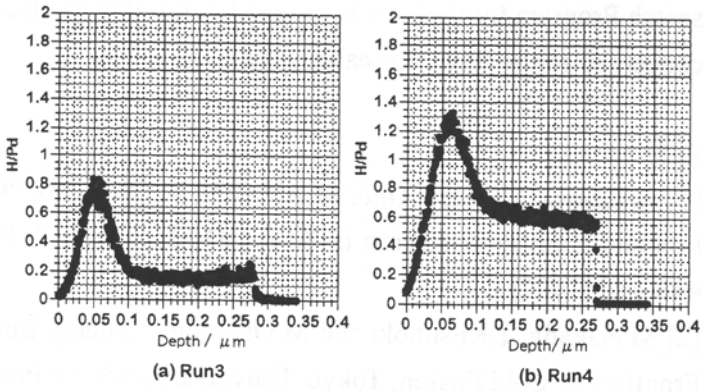

Figure 8. The depth profile of the loading ratio in the background run

Conclusion

A series of electrolysis in Pd-LiOD(H) systems has been operated to confirm the reproducibility of the anomalous phenomena under control the 7 key parameters.

The 7 key parameters have been discussed to find the anomalous phenomena with adequate successful reproducibility. In the present work, by the quantitatively complete controlling of the three parameters connected strongly to the materials, the reproducibility of the anomalous phenomena in Pd-LiOD electrolysis system can be realized with the clear appreciable correlation between the excess heat and the excess neutrons.

In the further study, the dynamic atomic interaction of the three elements, Pd-Li-D, in the Pd cathode will become very significant to elucidate the mechanism of the anomalous phenomena as mentioned above.

Acknowledgments

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