Heat Production at the Heavy Water Electrolysis Using Mechanically Treated Pd Cathode

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ABSTRACT

The heat balances of the heavy water electrolysis by Pd were measured in the closed cell. The excess heat with burst was observed three times out of 13 runs when mechanically treated Pd cathodes were used in 1 M LiOD solution. One of these was for Pd-Ag alloy (90:10) which began at 1,155 h after the start of the electrolysis, lasting for 240 h. The average output power was 105 % of the input during that time. The integrated excess heat was calculated to be 185 MJ per cubic centimeter of palladium. In this case the maximum excess power was recorded for this Pd.

1. Introduction

The excess heat related with the cold fusion phenomena, originally reported by Fleischmann et al., was reproduced by some researching groups. Some reports have demonstrated that the output power was several times larger than the input power. The characteristics of Pd has been considered to be a key for these unusual phenomena in heavy water electrolysis. In this paper the electrolysis with mechanically treated Pd cathodes has been studied with measuring the heat balance and the influence of these treatment on the excess heat generation will be discussed.

FRONTIERS OF COLD FUSION

2. Experimental

The heat balance measurements have been carried out in the 50 cm^3 acrylic electrochemical cell equipped with the catalyst for the recombination of deuterium and oxygen evolved to keep the system thermochemically closed. The flow calorimetry technique was applied; copper tube surrounds the cell where cooling water flows and picking up the generated heat by the electrolysis. The increase of cooling water temperature was measured by CA thermocouples and the flow rate was measured by a measuring cylinder. The output power was calculated by the following equation where T_1 is the input water temperature, T_2 is the output temperature, G is the flow rate, C_p is the specific heat of water and d is the density of water.

$$W_{out} = 4.184/60 \times (T_1 - T_2) G C_p d$$

The electrolysis was operated at the constant power, normally at 10 W (the current density was varied from 200 to 1000 mA /cm^2) . The electrolytes used were 1 M LiOD heavy water solution which was prepared from Li and D_2O (99.9 atom%) in Ar atmosphere and 0.1M LiOH or 1M LiOH light water solution.

Several kinds of Pd were used for the cathode. Among thirteen runs in heavy water electrolysis, five runs were performed for mechanically treated Pd cathode. After the cold roll, Pd (2 mm or 5 mm in diameter with 10 to 20 mm length) was quenched from 1,023 K to get the fine grain size and compressed to promote the internal stress. The other samples were used as received.

3. Results and Discussion

Figure 1 shows the heat balance in the 1 M LiOD electrolysis by Ag-Pd alloy cathode with mechanical treatment. The average output power exceeded the input by ca. 5 % during 1,150 h < t < 1,395 h. That is, excess power of 0.5 W was observed. The power excess reached 13 % in one time. In the other period of this run, Wout/Win kept from 98 to 100 %. The integrated excess energy of this run was 185 MJ/cm^3 Pd for 2,000 h. The other results were summarized in Table 1. Run 17 also showed abnormal increase of electrolyte by 1.4 ℃ at 934 h < t < 935 h and excess power reached up to 9 % at the same time. The energy created in this period was 900 J/cm^3 Pd. Excess power was **never** observed for Pd without the treatment. And the light water electrolysis which is listed as runs No. 4, 7, 8 and 10 in Table 1 showed no unusual behavior as to power balance.

Although the reproducibility should be checked more, these mechanical treatments possibly promote the excess heat.

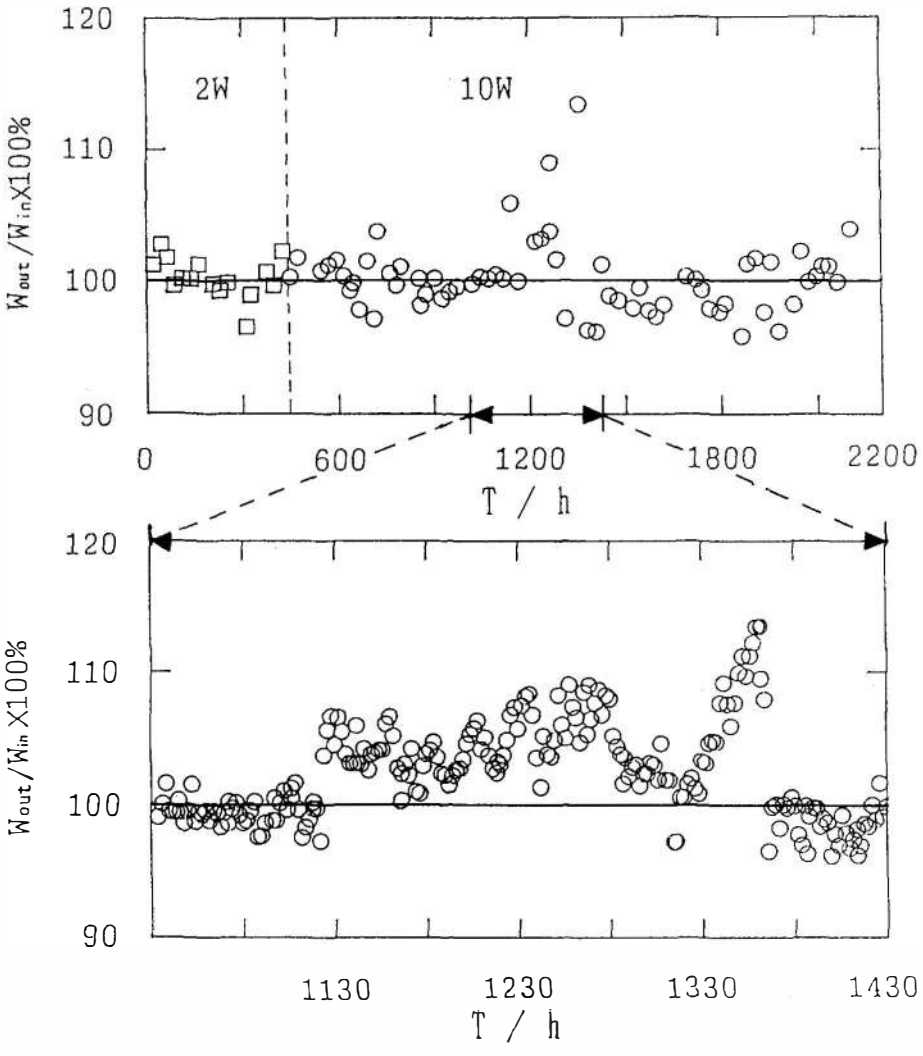

Figure1. Heat balance of electrolysis in 1M LiOD using mechanically treated Ag-Pd(10:90)

Table 1.The results of heat-balance measurement in power-stat electrolysis.

No	electrolyte	Pd dia. × long mm	coolant temp. °C	current density mA/cm²	Win W	Wout/Win electrolysis max. %	electrolysis time h
1	0.1M LiOD	2 × 20	23	500	8.6	96.9	200
2	0.1M LiOD	2 × 20	23	600～400	8.6	97.6	600
3	0.1M LiOD	2 × 20	23	420	8.6	102.5	600
4	0.1M LiOH	2 × 20	23	500	8.6	95.5	200
5	1M LiOD	2 × 20	5	1260～770	10	101.8	1500
6	1M LiOD	5 × 20	5	630～460	10	99.5	3100
7	1M LiOH	2 × 20	5	1200～440	10	101.1	400
8	1M LiOH	2 × 20	5	1700～960	10	104.3	2000
9	1M LiOD	※5 × 20	5	600～300	10	108.6	2000
10	1M LiOH	Pt	23	-	10	99.8	200
11	1M LiOD	2×20(Ag25%)	23	1400～530	10	99.2	2200
12	1M LiOD	※5 × 20	23	1000～500	10	102.9	890
13	1M LiOD	2×20(Ag10%)	23	1500～900	10	98.7	1900
14	1M LiOD	※5 × 10	23	890～250	10	113.4	2200
15	1M LiOD	2×20(Ag10%)	23	990～430	5	99.6	710
16	1M LiOD	※ 5×10(Ag10%)	23	570～490	5	100.8	1500
17	1M LiOD	※ 5×10(Ag10%)	23	490～160	5	103.2	1500

※ mechanically treated Pd

4. Conclusions

Although these unusual phenomena were detected three times during the heavy water electrolysis with Pd cathodes and the importance of the mechanical treatment was noted , the results have not been yet reproduced enough. Further careful experiments were required.