

Confirmation of heat generation and anomalous element caused by plasma electrolysis in the liquid

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Abstract

Plasma was formed on the electrode surface in a liquid electrolyte when a metal cathode was polarized in high voltage electrolysis in the solution. During the plasma electrolysis large amounts of heat are sometimes generated. The heat can exceed input substantially, in some cases by up to 200 percent of input power. At the same time, anomalous elements are detected in the electrolyte and on the electrode surface. Based on the heat and the product, we hypothesize a nuclear reaction can be induced by photon activation on the cathode element.

1. Introduction

We previously reported that anomalous isotopes are created on metal surfaces and surface regions, which cannot be explained by ordinary electrolysis.¹ In other words, this extruded material consists of elements, which cannot conceivably be contamination, because the isotopic distribution of most of the elements is unnatural. It is thought that this indicates what type of reaction affecting the nucleus has occurred. We expect to clarify the reaction mechanism by analyzing these reaction products. The plasma phenomenon has been in the literature²⁻⁹ for quite a long time. The reaction mechanism of plasma discharge is not understood in as much detail as ordinary electrochemical reactions.

2. Experimental Method

2.1 Electrolysis system

Heat was measured by a method that combined open cell isoperibolic calorimetry and flow calorimetry. The cell is a cylindrical glass vessel, 100 mm in diameter and 150 mm tall. A magnetic stirrer to ensure uniform temperature distribution mixes the electrolyte. It has two layers, or chambers. The anode, cathode and electrolyte are placed in the inner chamber. The outer chamber is filled with primary cooling water and heat exchanger coils (Teflon tubing). During electrolysis, secondary-cooling water flows through the coils and removes heat from the primary cooling water. Thermocouples are installed in the heat exchanger coils inlet and outlet, in Tee fittings, to perform flow calorimetry. Cooling water is circulated through the Teflon tubing from a constant temperature bath with an FMI precision metering pump with 1% precision; for example, 4.26 ± 0.05 g/s. This pump circulates water at any rate from 1 to 20g/s.

The flow rate is verified by collecting the water in a flask for a fixed period of time and weighing it on a precision scale.

2.2 Heat calibration

The heat balance is obtained with the following formulas:

$$\text{Input (Joules)} = I \text{ (current)} \times V \text{ (volts)} \times t \text{ (Time)}$$

$$\text{Output (Joules)} = H_w \text{ (heat of solution and cell)} + H_c \text{ (heat of coolant)} + H_r \text{ (heat release)} + H_v \text{ (heat of vapor)} + H_g \text{ (heat of water decomposition)}$$

All data, including voltage, current, temperature, and mass of secondary cooling water, are collected with a data logger for each 10s. Current is determined by measuring voltage through a shunt. Cell voltage is measured by attaching sensor wires directly to the electrode leads in the top of the cell. Data from the logger is captured by the computer, and finely recorded on diskette. All electric lead junctions from the thermocouples to the logger are compensated.

The heat balance was calibrated by changing the input power of the Joule heater immersing in the electrolyte. The out/input ratio stayed at 0.89 during the calibration run except when the cell was boiling, and during glow discharge boiling seldom occurred. The results show that a large change in input has no effect on the heat recovery calibration. In other words, changes in input power can be precisely monitored by the flow calorimetry method and by the open cell isoperibolic method. The only difficulties arose when the input power is very low, because the temperature precision was only 0.1C, and below 70W measurement accuracy suffered.

2.3 Electrolyte and Cathode Material Preparation

The electrolyte solution was prepared with Milli-Q pure distilled water that is filtered. It was used after being redistill in quartz glass. Ultra high pure reagents were used for the K_2CO_3 electrolyte. High purity of tungsten plate (99.98%) was used for the cathode. Platinum wires or mesh were used as the counter electrode and electrode lead wires.

2.4 Analysis of generated element

Materials in the solution and deposition bottom of the cell were calibrated by ICP analysis. The element on the electrode surface was analyzed by the EDX. The elements were then melted by an acid and calibrated by ICP method.

3. Results

When we increased the input voltage, excess heat was clearly generated. A typical result is shown in Figure 1. With a tungsten electrode of 0.5mm thickness; the graph on the left shows changes of input current, voltage and the electrolyte temperature during electrolysis. The figure on the right shows the input and output in watts and the ratio between them. The output heat showed slight excess comparing with the input power after 2,000s of plasma electrolysis start. After the 3,000s, the excess was considerably larger than the heat measurement error of 20W and reached 30-40W of average during the plasma electrolysis.

Tungsten samples of 0.3-mm thickness also produced significant excess heat generation. A typical result is shown in Figure 2. Excess heat was observed after only 100s of plasma electrolysis. At the time, the excess was considerably larger than the heat measurement error of 20W, reaching 40W average for the first 1,500s of plasma electrolysis. The output and input ratio changed over time. For the first 1,000s, excess was 20%, but after 1,600s it increased to around 60%, with fluctuations. The ratio again increased up to 300% after 3,000s then fell back to one after the voltage decreased to 100V. The total output heat power during plasma electrolysis was estimated as 388.7kJ while the total input electric power of 334.3kJ. Excess heat is 54kJ or 16% of input power.

After the voltage fell to 100V, the output and input ratio seems to fall gradually below unity. The ratio slowly increased after the voltage decreased into 60V. A possible reason is that the electrolysis temperature rose close to boiling point during glow discharge, and heat was lost to the water vapor released from the cell. Although we did not measure heat lost to vapor, the overall balance during glow discharge remained well in excess of unity because so much excess heat was generated. After the voltage was lowered, excess heat stopped although large losses to vapor continued, so ratio fell under unity. At 60 volts, glow discharge stopped, the boiling ceased, and the heat losses to vapor declined, so the balance returned close to unity.

It has been established that at the extraordinary excess heat generation is sensitive to many parameters, such as electrolysis and electrode material. Especially, it depends on the electrolysis temperature, input voltage and the duration of plasma discharge. We observed no excess heat at the beginning of the plasma electrolysis even the temperature and the input voltage were quite high, at 100V and 85°C. However, after several hundred seconds of plasma electrolysis, we always observed large excess heat generation. We conclude that if we attain sufficiently high temperature and voltage, and hold them, we observe excess heat with 100% reproducibility.

It is apparent that excess energy production depends on electrolysis voltage and the temperature of the electrolyte solution. The discharge voltage at which excess heat production begins is quite different as these conditions vary. Even when these conditions are satisfied, other parameters, such as the shape of the cathode, cause dissimilar discharge conditions. The spectrum of light from the reaction shows that two kinds of reactions can occur.¹⁰ A reaction in which hydrogen dominates in the spectrum, or a reaction in which the alkaline in the electrolyte and the cathode metal, which have no direct role in the reaction, are more pronounced in the spectrum. In the latter case the electrochemical potential near the electrode is large. We assume this affects the excess heat generation.

After excess heat was produced, many elements were found in the electrolyte, the eroded and precipitated cathode material, and on electrode surface. On the other hand, there were fewer elements when no excess heat was measured. Several elements were detected on the cathode surface after excess heat evolution, including Cl, Ca, Ti, Fe and Zn. The distribution of the elements was different in different parts of the electrode surface. Most were found around the center of sample. Meanwhile, other elements were detected in the solution, which were not the same as those found on electrode surface and the deposition at the bottom of the cell. Typical element distributions are shown in the Table 1. A clear difference can be seen between the case when excess heat was generated, and when it was not.

4. Discussion

In evaluating heat production, it is necessary to consider whether the heat might have been produced by chemical changes. After discharge electrolysis it is clear that the cathode material was worn down and precipitated to the bottom of the cell in the form of fine particles. Because this material was entirely made up of pure metal, the destruction must have been caused by hydrogen corrosion as well as heat damage. Therefore chemical changes cannot explain the heat. Ignoring the fact that this is impossible, let us consider some hypothetical chemical reactions:



In other words, if 183.85g of tungsten reacted, the maximum heat generation from this reaction would be 380kJ. The actual volume of excess heat measured using flow calorimetry was 54.4kJ for the case of plasma electrolysis with 200V of input for 3.1ks. The mass of tungsten removed in the reactions described above was 0.1g, and if we assume hypothetically that all of this material reacted, the heat would have been only 0.207kJ or 0.38% of the actual excess heat observed. The heat production in this experiment cannot begin to be explained as a chemical reaction.

This discussion has been predicated on the supposition that the tungsten underwent a chemical reaction, but in reality the tungsten found at the bottom of the cell was recovered as pure metallic fine powder, so no chemical reaction occurred. Furthermore, the decomposition of carbonates in a water solution is an endothermic reaction, so in this case 274kJ/M of heat would be absorbed, therefore even assuming that a reaction occurred no excess heat would be produced. Ordinarily, when metal is transformed into a hydride, it produces on the order of 200kJ/M, the exact amount depending on the metal. If a hydride was formed, based on the amount of tungsten lost from the cathode, the excess heat from the reaction should have been 0.1kJ approximately, which is simply too small to make a difference. In short, the actual heat that might have been produced from potential chemical reactions is essentially nonexistent.

5. Conclusions

According to many reported experiments, in almost all cases no radioisotopes have been detected, and no radiation or only very weak radiation such as neutron and other gamma or x-rays have been detected during and after the cold fusion experiment. We have to explain the fact by a plausible mechanism that produces no radioactive materials and might be triggered by the electrochemical reactions. Takahashi¹¹ has made progress the mechanism of photo-fission for the case of palladium, the material usually used in cold fusion experiments. We understand that the Takahashi hypothesis also applies to a tungsten electrode.

There are two peaks for the element distribution of the product of Tungsten electrode as shown in table 1. One peak is the major element of iron and zinc and other is the In. The total generated amount of element for the case of excess heat evolved was calibrated as the order of a milligram. Meanwhile, the total excess heat was calculated as on the order of 10^6 J from the products. The mechanism is well explained the excess heat evolution. We can say the photo-fission mechanism explain the amount of excess heat and the distribution of the element generation during the electrochemical treatment.

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Element	Before (mg)	After electrolysis Large excess heat	After electrolysis Small excess heat
Al	0.006	1.2	0.5
Si	1.4	2.0	1.5
P	0.5	0.5	0.5
S	0.4	0.6	0.6
Cl	0.8	1.0	0.85
Ca	0.06	0.45	0.12
Ti	0.001	0.8	0.15
Cr	0.001	1.4	0.005
Fe	0.024	2.5	0.055
Ni	0.001	0.02	0.004
Cu	0.14	0.03	0.16
Zn	0.001	0.75	0.001
Ge	0.01	1.2	0.01
Pd	0.01	0.5	0.01
Ag	0.01	0.12	0.01
In	0.01	1.1	0.01

Table1. Analytical results of the total element in the electrolysis system

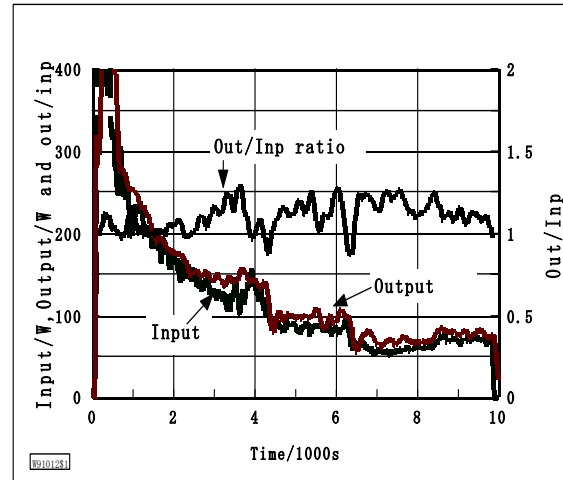
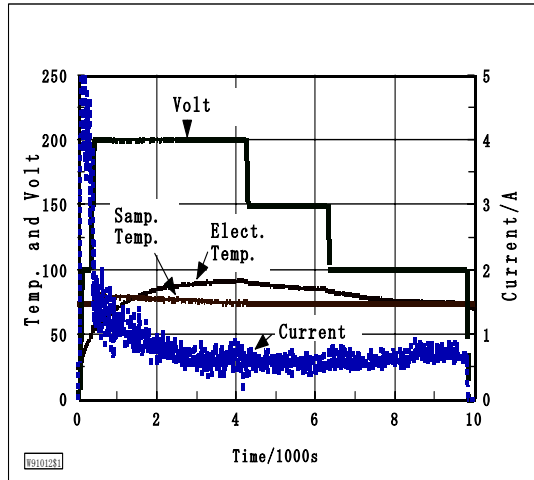


Fig. 1. Result of small excess heat of 0.5-mm thickness Tungsten plate in 0.2 M K_2CO_3 .
 Left: Changes of input volt, current, electrolyte temperature and electrode temperature (vertical scale, 1/10).
 Right: Changes of input, output and their ratio during plasma electrolysis.

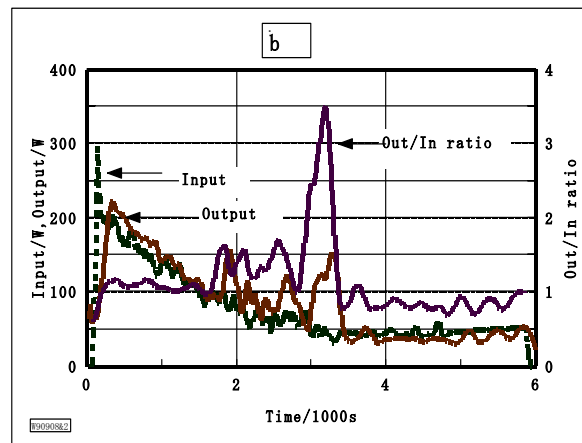
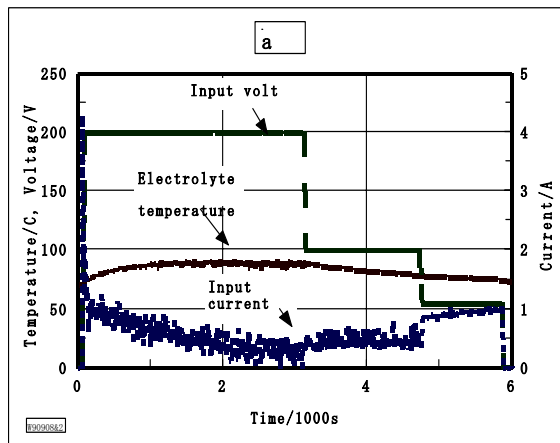


Figure 2. Result of large excess heat generation during plasma electrolysis of Tungsten electrode.
 Left: Changes of input voltage, current, electrolyte temperature.
 Right: Changes of input, output and their ratio during plasma electrolysis.