On the Explosion in a Deuterium/Palladium Electrolytic System

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Abstract

An explosion in a D / Pd electrolytic system is analyzed, it is not chemical explosion but cold fusion reaction. A possible mechanism of cold fusion is suggested in this paper.

Keywords

explosion, cold fusion, Deuterium / Palladium electrolytic system

1. Introduction

Since the announcement of cold fusion by Fleishmann and Pons[1], there have been a lot of research works on D / Pd system in the world; a lot of explosion in D / Pd systems especially in D / Pd electrolytic systems have happened, the explosion happened at SRI International[2] was a famous one. It was suggested that explosion in D / Pd systems is caused by Oxygen / Deuterium recombination[2]. In our D / Pd electrolytic experiments, three explosions happened in April 1991, after measuring remains of an explosion, we induce another conclusion: explosion caused by cold fusion in Pd tube.

2. Electrolytic cell and explosion case

The electrolytic system was composed of a glass measuring cylinder (Φ25.5 $\times$ Φ23 $\times$ 186mm, $\sim$ 80ml), heavy water ($\sim$ 39cm^3), Pd tube (Φ1.67 $\times$ Φ0.67 $\times$ 80mm) cathod and Pt wire anode, a rubber plug of round platform (Φ27 $\times$ Φ21 $\times$ 22mm, $\sim$ 15.5g) stretched in measuring cylinder about 12mm and sealed the top of the cylinder but a blowhole(Φ3mm, gas could escape through it), the volume of gas above heavy water in the cylinder was about 33.3cm^3. The cell was placed in a water bath ($\sim$ 530ml light water in it).

There had been three explosions in these D / Pd electrolytic systems in April 1991. In two explosions, the rubber plug with Pd tube and Pt wire had

flown off about 1.5–2 meter away, the bottom of cell had been blown out, D_2O in cell had been mixed with H_2O in bath. Because no one on the scene of explosions, the tempeature of water in bath was measured about half hour after one explosion happened, it raised 5 ° C. Before the explosion, the applied voltage on cell was 7.5V and current was 260mA, it had been running for about 50 hours.

3. Explosion analysis

First, tempearture of 530ml water raise 5 ° C, it need $\Delta Q = 1.1 \times 10^4 J$ at least (conduction of heat is not concerned).

Second, as a result of simulation test, it need 2.1Kg force for the plug flying off, corresponding excess pressure $\Delta P = 5.12 \times 10^4 Pa$, it is to say that the minimum pressure in gas cylinder of cell is $1.53 \times 10^5 Pa$. Because of the electrolytic cell is a open system, the D_2 and O_2 gas producted in electrolysis can escape from the blowhole easily, so the excess pressure in cell can't accumulate generally; but, if only there is a lot of gas be producted in short time (τ) in cell and high excess pressure is formed, the gas can't escape through the small hole efficiently, so the rubber plug is pushed out and flying off, the bottom of cell is blown out resulting rocket action. Leading to this result, there are two possible cases:

<1> O_2 / D_2 recombination causes chemical explosion. Volume of gas cylinder in cell is $33.3cm^3$, calculating the release heat Q by the best O_2 / D_2 mixing ratio.

$$2D_2 + O_2 = 2D_2O + 67.8Kcal$$

Q = 281J. It is more less than the practical heat.

We consider another limit situation, the space above heavy water in cell is filled with O_2 gas and O_2 combines with D_2 gas released from Pd tube in short time to form water, the corresponding heat is 843J, it is only $\frac{1}{13}$ of the practical heat and this kind of heat can't heat up heavy water efficiently, so the practical explosion can't be caused by chemical reaction.

<2> Heat burst caused by cold fusion in Pd tube. Lots of heat released makes the tempearture of Pd tube raises thousands degrees and heavy water around it vaporized rapidly, the heavy water vapor makes the pressure in cell increases speedly and explosion happens.

We can estimate the upper limit of τ

$$\tau = \frac{L}{V_{eff}} = L\sqrt{\frac{\rho_0}{\Delta P}}\left(\frac{\Phi}{\Phi_1}\right)^2$$

where L = 8cm (height of gas cylinder), $\Delta P = 5.12 \times 10^4 Pa$, $\Phi = 2.3cm$ (inner diamter of the cell), $\Phi_1 = 0.3cm$ (effective diamter of hole), $\rho_0 = 0.0009g / cm^3$ (density of heavy water vapor of 1 atm).
the result is $\tau = 0.0579S$

the energy production rate is

$$P \geqslant P_{min} = \frac{\Delta Q}{\tau V} = 1.11 \times 10^6 W / cm^3 (Pd)$$

V is volume of Pd tube, $V = 0.147 cm^3$.

The heat burst in the explosion reached MW per cm^3Pd.

There had been an explosion in a D / Pd electrolytic system at SRI International on January 2, 1992 too, because it may be a close system and the parameters are complex, we can't reach clear conclusion on it, but it is possible that it was a cold nuclear fusion explosion too.

3. A proposal for mechanism of cold fusion

Where such large excess heat comes from? Why the heat mismatches products nucleus? it is puzzle for us and very difficult to explain within the domain of the physical and chemical knowledge now availabe, it is possible that new physics appear in it. Two year ago, the first author of this paper provided a hypothesis as follows[3]:

A small part of the rest energy MC^2 connected with the rest mass M of deuterium can be transformed directly into utilizable energy, this process called as RDTME can be written into the form that

$$D_1 + D_2 \longrightarrow D_3 + D_4 + \varphi \qquad \cdots(1)$$

in which D_i($i = 1-4$) represent deuterons with rest mass M_i respectively, and ,

$$M_3 = M_1 - \Delta M_1, \qquad M_4 = M_2 - \triangle M_2 \qquad \cdots(2)$$

$\varphi = (\triangle M_1 + \triangle M_2)c^2 > 0$ is the energy which can be released as the kinetic energy of electron, deuterons and / or the energy of photon. It seems that the value of φ mainly distributes from 1 ev to 20 kev.

The reaction mentioned above takes place only under certain specific artificial circumstances with, especially, some kind of electronic screen. The condition under which F–P's cold fusion takes place is one of these specific artificial circumstances.

Furthermore, we suggest a possible mechanism of excess heat released in RDTME .

In PdDx , TiDx or other Deuterium / Metal system, when a free electron transits to a specific state in which the electron can screen the coulomb repulsive force between two D nuclei i.e. the electron comes into a bound state, the photon may be emitted. Due to some possible yet unknown relation between the electromagnetic interaction and the strong interaction, D nuclei may provide a energy $(\triangle M)\, c^2$ connecting with its rest mass M_D to the electron, then, the electron can get back to the initial state and emit photon again. This process may repeate several times under certain specifical conditions, as a result,the excess heat is released continuously.

We devided the screen state in which the electrons can get into two kinds: weak screen(w–s) and strong screen(s–s).When the electrons transit to w–s state, only lower energy photons are emitted without any traditional light nucleus fusion taking place; When the electrons transit to s–s state, besides the

energetic photons being emitted, various fusions of deuterium may sometimes be ignited. Obviously,the probability that the electrons get into w–s.state is much more large than that the electrons get into s–s state, so the production of excess heat is far more than that of the nuclear particles . Thus the puzzle of the huge mismatch between the excess heat and the nuclear reaction generating particles is solved naturally. At the same time, we may understand the possible correlation existing between the branching ratio of cold fusion and the temperature, pressure and other enviroment parameters in the PdDx or other Deuterium / Metal Systems.

The screening effect existing between two deuterons caused by the mobile electrons and deuterium ions D^+ in the lattice of PdDx etc. have been discussed in many papers. This effect can make the coulomb repulsive barrier weaker , then may enhance, perhaps greatly, the probability of fusion taking place between the low energy deuterons. But the screening mechanism have not yet explained the mismatch between the excess heat and the fusion products as well as the such large fusion rate obtained in the experiments.

Similarly to the reaction (1), the fusion reaction between protons and between proton and deuteron can take place too. That is to say, the light–water–electrolysis can also generate the excess heat in spite of small.

Reference

(1) M.Fleishmann, S.Pons and M.Hawkins, J.Electroanal. Chem. 261 (1989)301

(2) New Scientist January 11, 1992

(3) Zhang Xinwei et al.,

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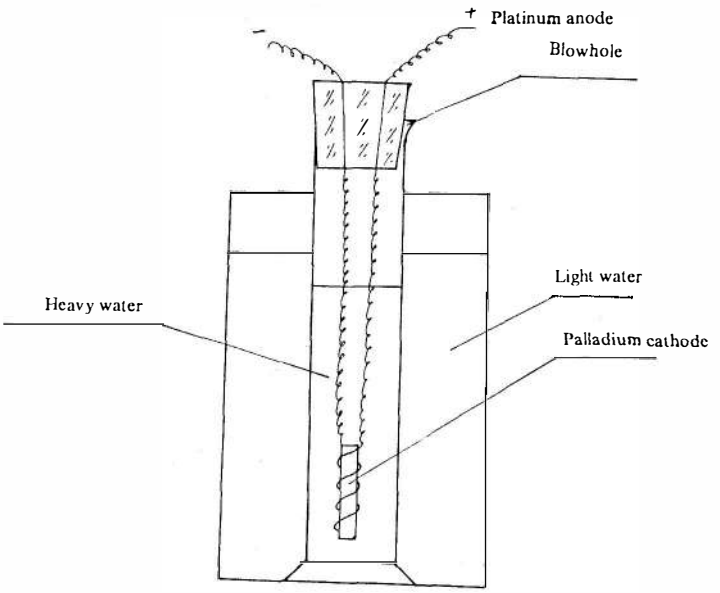

Fig.1 Experimental set–up