Discuss the abnormal exothermic phenomenon " cold fusion "

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Abstract. The research on cold fusion phenomenon has been in the past 30 years. Based on the research results of the predecessors, this article comprehensively describes the research results of the predecessors on the cold fusion phenomenon, and discusses it theoretically and experimentally. From the perspective of thermodynamics, this paper proposes to charge the palladium wire with hydrogen at low temperature to increase the frequency of abnormal heat generation, and gives a calculation formula for the hydrogen charging rate of the palladium wire. At the same time, a theoretical solution model for the isotope effect on the abnormal heat release phenomenon is proposed.

1 Introduction

In 1989 M. Martin Fleischmann and Stanley Pons [1] announced that when using palladium as the metal cathode and platinum as the cathode to electrolyze heavy water, they observed an exothermic phenomenon far beyond ordinary physics and chemistry. It is guessed that at the electrolysis process of heavy hydrogen atoms, a large amount of energy is released due to polymerization reaction for some reason. The announcement of this news immediately shocked the scientific community. If nuclear fusion can react to with room temperature, it will bring endless energy to mankind. However, the research on cold fusion has not been smooth sailing.

It was questioned by traditional nuclear physicists at the beginning of its birth. Even today, the research on cold fusion has made great progress, and the voices to doubt are still one after another[2]. The reason is that cold fusion has not yet had a complete set of theories to explain its heat release mechanism and heat to release mode.

2 Discussion of related theories

In the 30 years since the development of cold fusion, many scholars have put forward their research theories. Just like the beginning of many discoveries, there are various explanations. At the beginning of the cold fusion report, AliF AbuTaha[3] pointed out that the abnormal exothermic phenomenon does not come from the nuclear fusion reaction, but from the deformation of the metal cracks in the metal. Some scholars believe that these abnormal exothermic are caused by the heat released by the hydrogen catalytic reaction, similar to hydrogen embrittlement. However, according to the literature[4], stop the input energy, exothermic phenomenon still lasts dozens, even hundreds of hours.

which just shows that it is not caused by these Caused by physical phenomena. Therefore, scholars from various countries have put forward their own view. At present, there are dozens of theories explaining the occurrence of cold fusion, such as the tetrahedral symmetry TSC theory[5], quantum tunneling theory[6], and deep electron theory[7]. Disturbance theory[8], phonon theory[9], etc, most of which focus on quantum mechanics, Based on the following four nuclear fusion reaction equations. There are three issues worthy of discussion, how to make hydrogen and its isotopes overcome the atomic barrier captured by atoms, how to reduce the reaction barrier, and how to apply external energy to it to cause hydrogen to polymerize.

$$^{2}\mathrm{H}+^{2}H\rightarrow^{3}He+n,Q=3.25MeV \quad (1)$$

$$^{2}H+^{2}H\rightarrow^{3}H+p,Q=4.00MeV \quad (2)$$

$$^{3}He+^{2}H\rightarrow^{4}He+\mathrm{p},\ Q=18.3\mathrm{MeV} \quad (3)$$

$$^{3}H+^{2}H\rightarrow^{4}He+\mathrm{n},\ Q=17.6MeV \quad (4)$$

The author believes that the focus on research on cold fusion anomalies is not on the two words fusion, but on exothermic heat. The theory based on thermonuclear fusion will inevitably conflict with traditional nuclear physics theories. The main focus is on the energy source required for the fusion of the atomic nucleus to overcome the atomic barrier, and the products after the nuclear reaction. Although high-energy particles and ^{4}He have been found in related experiments, the frequency of these phenomena is currently low. For this, Google[10] in 2019 The investigative team of published a research report in which no high-energy particles were found. Therefore, the focus on this research should be on the abnormal heat release of metal hydrogen charging.

3 Discussion of related experiments

For the anomalous exothermic phenomena in cold fusion, the main research directions are gas and liquid phase, and three specific experimental methods are divided into them.

At present, the mainstream experiments mainly from

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the following three aspects.

3.1 Metallic material

Scholars from various countries have designed different types of ground materials in order to verify whether the abnormal heat release phenomenon is related to metal materials and internal structure. S Focardietal designed the abnormal heat release trigger for the Ni-H [11] system. In the experiment, the input power is stopped. At that time, its abnormal exothermic power was maintained at an average of 44w per day for up to 44 days, but no high-energy particles were found.

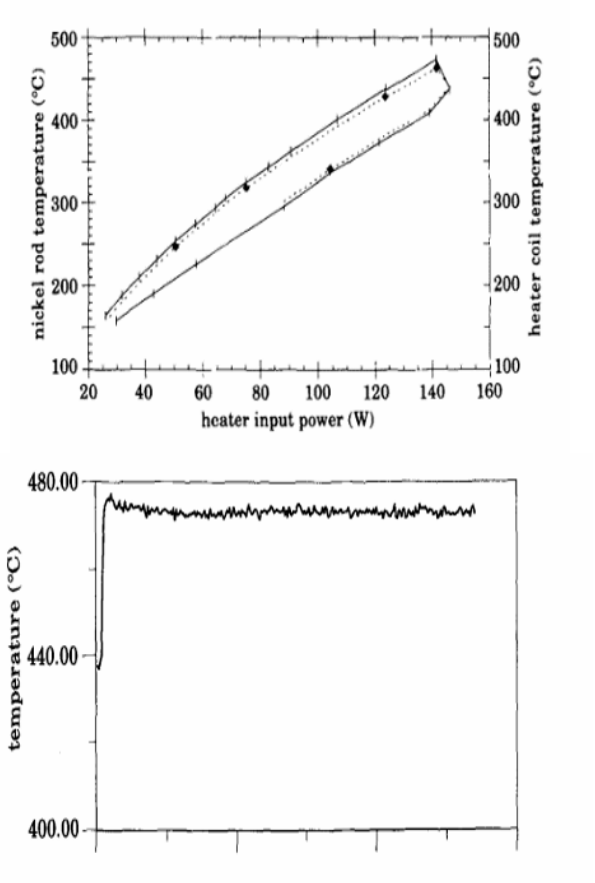

Fig.1 The abnormal exothermic phenomenon of the experiment of S. Focardietal.

The relevant experimental report proposed that when hydrogen enters the metal to reach 0.875[12], the proportion of abnormal heat released will be greatly increased. For this reason, some researchers have adopted other experimental methods, such as the use of palladium alloys and heat treatment of palladium alloys, or embedding palladium atoms into other materials, or in the form of metal powder, or using magnetron sputtering. Plating palladium atoms onto other metal surfaces and so on. According to Gibbs free energy and related thermodynamic formulas[13].

$$\Delta G^{-} = \Delta H^{-} - T\Delta S^{-} \quad (5)$$

$$\Delta G^{-} = -RTLnK_n = RTln^{ph_2} \quad (6)$$

$$ln^{ph_2} = \frac{\Delta H^{-}}{RT} - \frac{\Delta S^{-}}{R} \quad (7)$$

(ΔG^{-} Gibbs free energy ΔH^{-} metal hydride formation enthalpy; $\Delta S^{-}$is the entropy variable; R is the gas constant)

The hydrogen and hydrogen isotopic molecules entered the metal to form a hydride with the metal. Its reaction is an exothermic reaction. For this reason, it is worth exploring to use low temperature to charge the metal with hydroGen.

However, the internal crystal structure of different metals is different, and the hydrogen absorption capacity is also different. Since the hydrogen absorption of metal is a reversible reaction, how to maintain dynamic equilibrium after hydrogen enters the metal and maintain the ratio of 0.875 is the focus of the experiment. For this reason, various laboratories are replacing different materials to find ways to improve the hydrogen storage rate. There is also the idea that defects in the crystals of metals, and other internal structures, are affected. In experiments by some scholars, $LaAlO_3$ compounds[14] have been used for thermal triggering experiments. Because this material changes its color when hydrogen enters its interior, it triggers abnormal exothermic phenomena by applying pressure and electric currents.

For this reason, we give an empirical formula based on a large number of experimental results. Calculate the ratio of palladium atoms to hydrogen atoms in the palladium wire by calculating the resistance change of the palladium wire before and after the experiment, (Change of resistance of palladium wire with temperature in natural state of K_0 Change of resistance of palladium wire with temperature under hydrogen charging state of K, Q is the hydrogen charging rate)

$$Q = \frac{K - k_0}{k_0} \quad (8)$$

3.2 Selection of hydrogen and deuterium

Previous experiments, according to Ni-D systems and Ni-H systems, found that hydrogen and hydrogen isotopes have similar functions, can trigger abnormal exothermic phenomena, Japanese scholars proposed that hydrogen and hydrogen isotopes have isotopic effects[15],There is a difference between the heat released by hydrogen and deuterium.

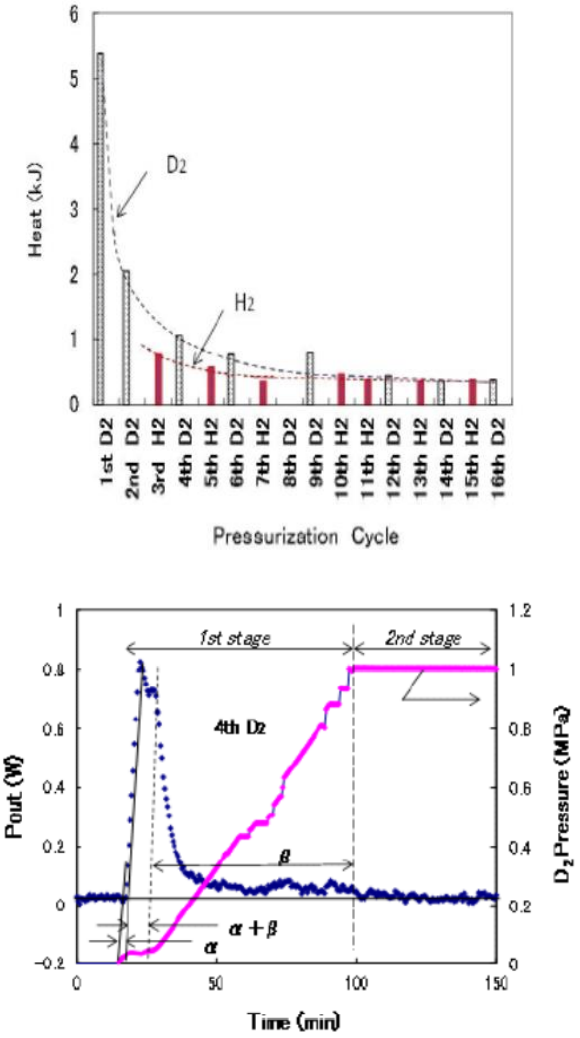

Fig2. Tatsumi Hioki, et al. Discovery of isotope effect maps

The abnormal exothermic ability of hydrogen and deuterium will have a thermal difference under certain conditions. This is due to the polymerization reaction to hydrogen and hydrogen isotopes in the crystal[16]. The author believes that the difference in heat released between hydrogen and hydrogenisotopes is Because the crystal has the following reaction.

$$H + H \rightarrow {}_1^2H + \text{Energy absorption} \quad (9)$$

$${}_1^2H + {}_1^2H \rightarrow {}_2^4H + Release\ energy \quad (10)$$

$${}_1^2H + {}_1^2H \rightarrow {}_2^3H + n + Release\ energy \quad (11)$$

When using hydrogen as the reaction gas, the reaction sequence in the crystal is (5), (6) or (7), and deuterium as the reaction gas is only (6) or (7), so hydrogen is used as the experimental material to release The energy of is less than deuterium.

3.3 Detection of reaction products

The reason why the abnormal exothermic phenomenon is called the cold fusion reaction was pointed out in the relevant literature at the beginning of the study that there are energetic particles and ^{4}He in the reaction process, in H.Aizawa,[17]andYu.N.Bazhutovetal[18].

In the experiment, high-energy particle streams and direct neutrons were observed.

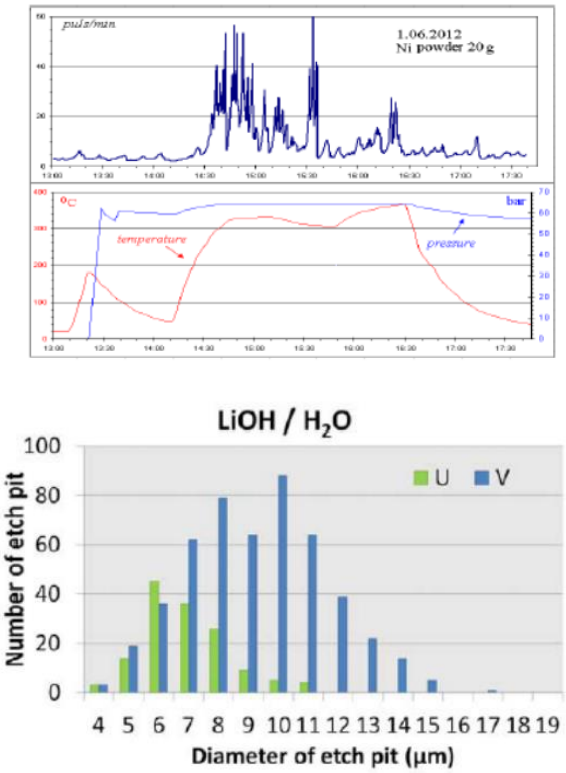

Fig3. Two highenergy particles of different energies were observed in the experiment. A neutron burst was found in the exper-iment.

Here is still a lot of controversy as to whether there are high-energy particles or ^{4}He in the experiment. In the previous literature, the production of high-energy particles and ^{4}He was not detected during the abnormal heat release. Therefore, the monitoring of high-energy particles and ^{4}He is also the focus of the experiment.

3.4 Experiment trigger method

In previous experiments, the researchers found that different experimental trigger conditions play a crucial role in the occurrence of abnormal heat released. At the beginning of the experiment, the electrolysis of heavy water was used to trigger the experiment. Later, through a large number of experimental studies, it was found In many cases, abnormal exothermic phenomena can be triggered, such as applying current and pressure to the hydrogen-charged palladium wire, laser, ultrasonic, and glow discharge, etc.

Therefore, the choice of triggering conditions is still the focus on the experiment. The author believes that, The choice of the experimental trigger method should consider the trigger effect while considering the economy, so as to facilitate future production and promotion.

4 Conclusion

So far, cold fusion research has a history of more than 30 years. Most of them focus on the measurement of

abnormal exothermic phenomena. However, there is no complete theory to explain the abnormal exothermic phenomenon. Some related theories only explain the reason for the abnormal exothermic phenomenon from one aspect, and the related theories have not been verified by experiments.

How to overcome the barrier between nuclei and nuclear products still needs our continuous in-depth research. It is believed that in the near future, research on abnormal heat release will make great progress.

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