Cold Fusion Reaction Products and Behaviour of Deuterium Absorption in Pd Electrode

Tadahiko MIZUNO, Tadashi AKIMOTO, Kazuhisa AZUMI
Dept. Nuclear Eng., Fac. Eng. Hokkaido Univ.
Michio ENYO
Catalysis Research Center, Hokkaido Univ.

ABSTRACT

Excess heat generation from Pd electrode during cathodic polarization in D_2O-LiOD solution was investigated as a function of D/Pd loading ratio. The excess heat was observed when a Pd sample was filled with deuterium to D/Pd $\approx$ 0.90 by cathodic charging. The excess heat (H_{ex}) Increased with D/Pd in an exponential manner ; the H_{ex} was of the order of magnitude of 0.1 watt/cm^2 at D/Pd $\simeq$ 1.0.

Experimental

Electrolysis was performed in a closed cell which was made of stainless steel and having a Pt black recombination catalyst located at the upper inner part of the cell. The lid of the cell accepted two with different area Pt anodes , Pd cathode, three temperature sensor connectors, a pressure gauge connector and a gas sampling port.

The cell was set in a constant temperature space which was surrounded by a water reservoir of $\pm$ 0.1 ℃ stability. The electrolyte was stirred by a magnetic stirrer which was set under the cell. Temperature was measured within 0.03℃ of accuracy by means of three digital voltmeters connected to each thermocouples (T.C.); these were fixed at various part in the cell. The other junctions of each T.C. were immersed in the water bath.

The temperature change during electrolysis was calibrated by operating two of Pt electrodes with various electric current. Experiments were performed at around 100℃ and current density of several hundred mA/cm^2.

FRONTIERS OF COLD FUSION

Experimental results

Figure 1 shows a change of D/Pd loading ratio, temperature and cell voltage during electrolysis with 0.2A/cm^2. The deuterium absorption process showed two steps; the first step occurred immediately after the start of electrolysis and the second step started when the loading ratio reached the value of β phase. The absorption rate in the second step was slower than the first step by two orders of magnitude.

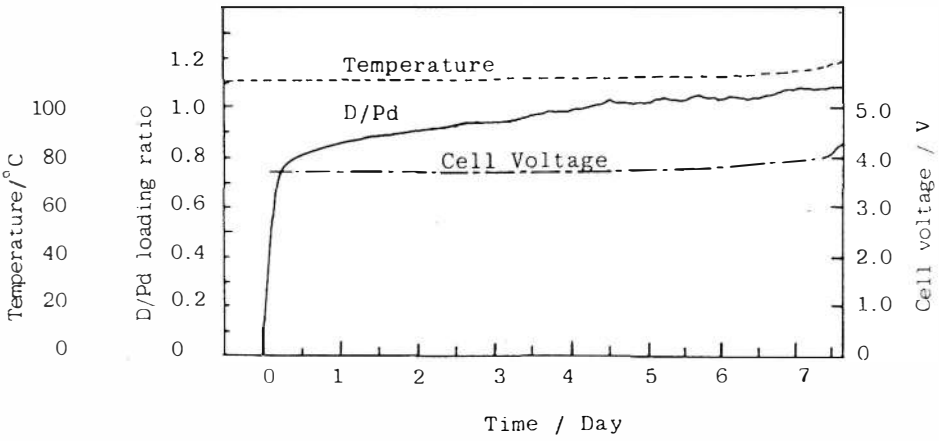

Fig.1 Changes of D/Pd loading ratio, temperature and cell voltage during electrolysis with 0.2A/cm^2 in 0.5 M/dm^3 LiOD solution.

The loading ratio attained after the slow step was completed was dependent on the electrolysis conditions such as temperature and current density. The D/Pd ratio reached 1.1 after 7 days of electrolysis. In this case, temperature and cell voltage started to increase after 7 days of electrolysis ; this may be caused by an increase of resistivity of the Pd metal due to high concentration of deuterium absorption.

The excess heat production was observed when the D/Pd ratio reached to almost unity; it continued and still increased with further increase of D/Pd ratio. The H_{ex} generation was apparently dependent on the D/Pd loading ratio, but not on

cathodic current density. The relationship between H_{ex} and D/Pd ratio was investigated by changing the temperature and the current density. After 7 days of electrolysis with $0.2A/cm^2$, the current density was increased step by step up to $0.4A/cm^2$, and at each steps it was kept for 7 days. The loading ratio usually reached to a constant value within a day.

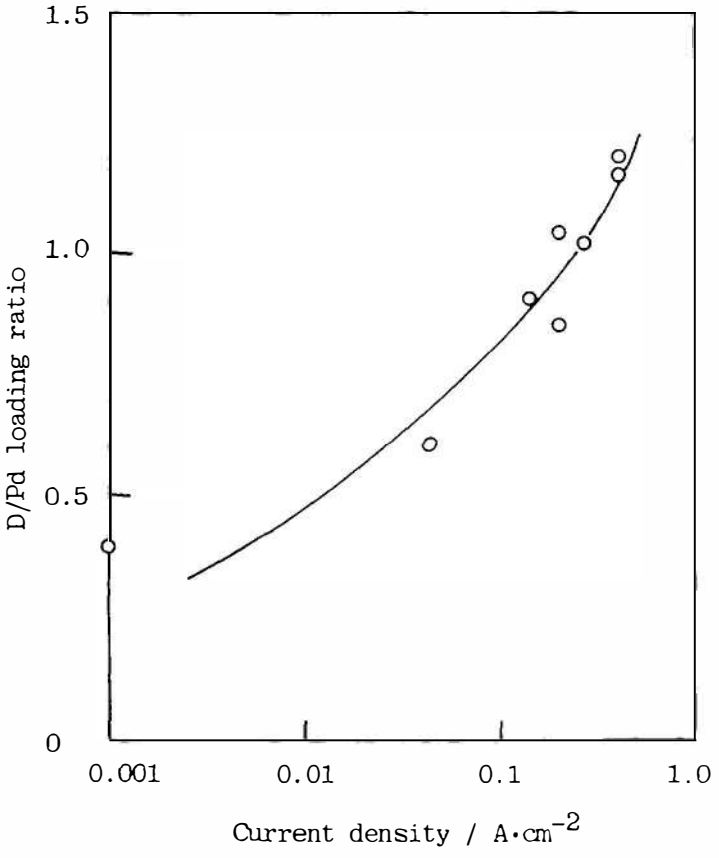

Fig.2 Effect of cathodic current density on the D/Pd loading ratio.

Figure 2 summarizes the effect of cathodic current density on the D/Pd loading ratio. The loading ratio of unity could be obtained by electrolysis of 0.2A/cm^2 at 100℃. The D/Pd value at the lowest current density of 0.001A/cm^2 showed a tendency to increase; the value shown in Fig.2 was obtained after 7 days.

Figure 3 shows the relationship between H_{ex} and D/Pd ratio obtained under various electrolysis conditions. The H_{ex} seems to increase exponentially with the D/Pd loading ratio, but its precise form is still not clear. The H_{ex} generation was 0.07 w/cm^2 when the D/Pd ratio was close to unity.

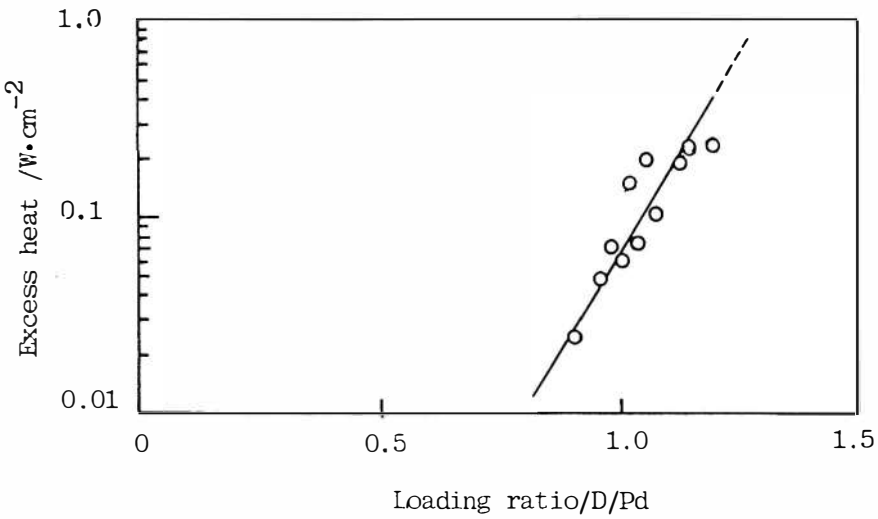

Fig.3 Relationship between H_{ex} and D/Pd ratio obtained under various electrolysis condition.