Field Formation of the Condensed Matter Fusion by Electro-Transport of Deuterium in Palladium

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ABSTRACT

A model of cold fusion was proposed. Electrotransport effect on deuterium in palladium was crystallographically examined and verified for the field formation of the condensed matter fusion. Electrotransported palladium hydride was analyzed by neutron radiography technique. The effective number of the electric charge of hydrogen in $PdH_{0.67}$ was evaluated to be $+0.30\pm0.05$.

1. Introduction

This paper concerns (1) to propose a model of electrotransport (ET) effect on deuterium (D) in palladium (Pd) for the field formation of the condensed matter fusion (cold fusion), (2) to verify the effectiveness of the D densification in PdD, (3) to visualize the hydrogen (H) distribution in PdH by neutron radiography, and (4) to analyze its intrinsic physical property. PdH (D, T) is a well-known material which shows superconductivity, and its transition temperature depends on its nonstoichiometry [1]. In order to prepare the high H density ((H/Pd) ratio>1) in PdH, electrolysis of water as well as absorption of H under high pressure and cryogenic temperature had been applied by many investigators [2]. On the experiment for the cold fusion, the same approaches had been adopted for the hydrogenation of Pd and Ti. When modeling the system analytically in the case of the electrolysis of heavy water, we must take into account of not only electrolysis process (<1>+<2>) but also ET effect on H in Pd metal under electric field (<3>+<4>) as shown below:

$$D^{+}_{aq}=<1>=[Pd+D]_{ads}=<2>=PdD_{surf}=<3>=PdD(\alpha)_{bulk}=<4>=PdD(\beta)_{bulk}$$

Diffusion of H in bulk Pd under external forces such as ET and thermotransport [3] is an important subject. Especially the ET effect is an essential factor.

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2. Theory of ET of D in Pd

A model of the ET of D in Pd metal matrix for the field formation of the condensed matter fusion (cold fusion) is shown in Fig. 1. D as well as H and T are transported and compressed at the anodic side (-) of the Pd specimen by the applied electric field (E). The expression of the process was given by force of ET and Fick's second law [4, 5]. The driving force of the ET of D in metal is presented by $F = e E Z^*$. Here e is the electron charge unit, E the applied electric field and Z^* the effective number of the electric charge of D in metal. The H number density in the metal matrix at the anodic side (-) is evaluated to be approximately multiplied by $\exp(-eEZ^*/kT)$ in comparison with that of the cathodic electrode side (+) for specified initial and boundary conditions. This principle has been applied to the transportation and densification of D as well as H in the Pd metal and Pd alloy (Pd (Au, Ag)) in order to verify experimentally its effectiveness and to simulate the field formation of the condensed matter fusion.

3. Experiments

3. 1. ET of D in Pd (Au, Ag)

First experimental run was conducted to verify the ET effect on D in the process of the densification of D in the Pd metal matrix. A special ET Pd alloy electrode was prepared as shown in Fig. 2. The Pd alloy part were plated with Cu and Au thin film to hold D in the bulk Pd alloy. The electrode was set up in the heat pipe temperature control system as shown in Fig. 3. D_2 gas ($2.6 kg/cm^2$) was supplied to be absorbed by the Pd alloy electrode. 40A-7V DC was applied to the Pd electrode at about 100℃ for 21days before Pd-sheet fused down. The typical experimental conditions were indicated in Fig. 3. From the X-ray diffraction analysis of the electrotransported Pd (Au, Ag) D, the D transportation and densification in the electrode was evaluated crystallographically.

3. 2. Neutron Radiography of H in ET Pd Metal

Second run was carried out for the analysis of H distribution in Pd. The experimental condition of the ET was similar to that of the first run. Pd metal wire (2.0mm in dia.) with heat treatment (1000℃, 2h, in vacuum) was prepared as the ET specimen. The Pd wire about 50mm was attached to Cu electrodes, and hydrogenated at 160℃ for 10h under 0.2 MPa H_2 gas. Then the hydrogenated Pd wire with Cu electrodes was plated with Cu (0.02mm) and Au (0.01mm) double layers by electrolysis. The ET element was set up in the similar manner as shown in Fig. 3. The transportation, redistribution and densification of H in PdH by the ET function was carried out under the experimental conditions; temperature around 120℃, applied DC power of 47A-55mV, and overall operation of 9 weeks. H distribution was tested nondestructively using neutron radiography for the PdH sample electrotransported for 3, 6 and 9 weeks.

4. Results and Discussions

4. 1. PdD Lattice Parameter

The lattice parameter of the fused electrotransported Pd(Au, Ag) element was evaluated as shown in Fig. 4. Axial distribution of the lattice parameter was illustrated with the estimated axial profile of the applied electric potential and Pd(Au, Ag) sheet temperature. The position of the arrow indicated the fused section of the Pd-sheet after 21 days operation. The lattice parameter of the Pd-sheet after annealing at 200℃ was also plotted. The difference of the lattice parameter of Pd alloy sheet between as ET and after annealing is considered to be proportional to the D content in the ET element. This shows that the ET effect in the D absorption of the Pd alloy was confirmed.

4. 2. Neutron Radiographic Analysis of PdH

The redistribution of H in PdH by the ET was visually confirmed by neutron radiography [5]. Fig. 5 shows the time-dependent redistribution of H in PdH by the ET process. The homogeneous H of initial (H/Pd) ratio of 0. 67 was redistributed to the linear distribution from 0. 55 at the positive electrode side to 0. 70 at the negative electrode side after 9 weeks operation. From the H distribution, the effective electric charge number of the H atom in PdH was evaluated to be about 0.30 ± 0.05. This value is lower than the literature value (0. 54) due to much higher H content (0. 55-0. 70 in (H/Pd) ratio) in the present case than 0. 01 in (H/Pd) ratio in the literature cases [3].

5. Conclusions

In conclusions, the ET effect on D in PdD was proposed for the modeling of the field formation of the condensed matter fusion (cold fusion) and verified experimentally. The effectiveness of the ET for the D and H densification in the Pd was confirmed by the X-ray diffraction analysis as well as neutron radiography.

6. Acknowledgement

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7. References

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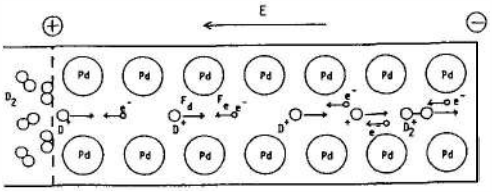

Fig.1 Model of Electrotransport of Deuterium in Palladium Metal

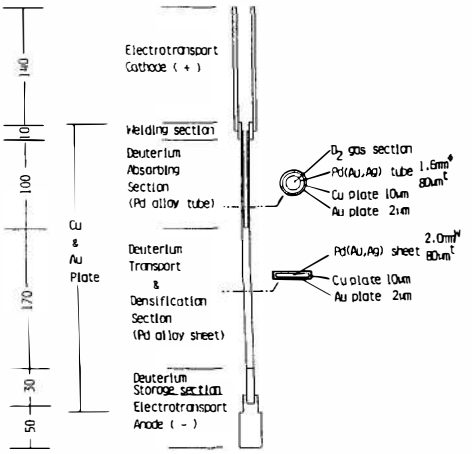

Fig.2 Pd(Au,Ag) Electrotransport Element

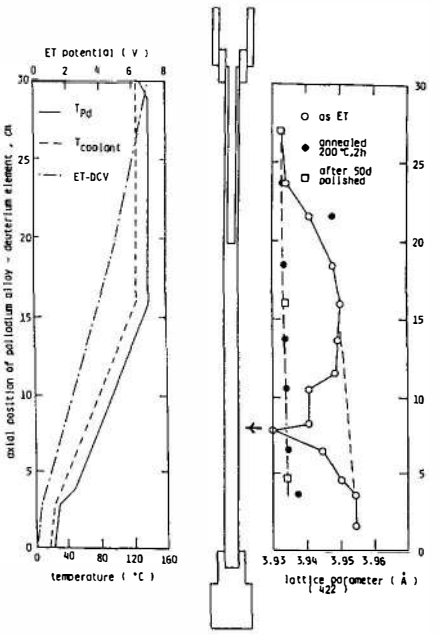

Fig.4 Axial Distribution of Electric Potential, Temperature and Lattice Parameter in the Electrotransported Pd Element

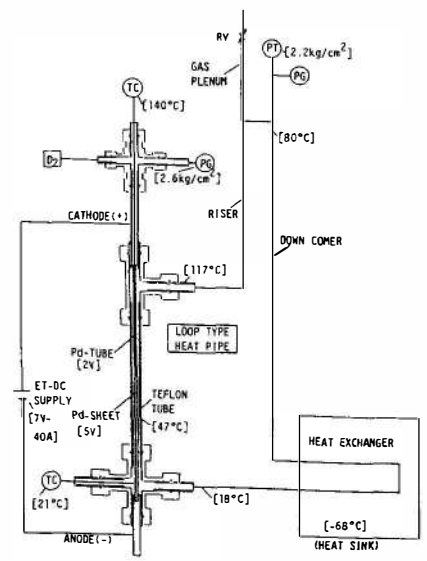

Fig.3 Experimental Setup for Electrotransport of D in Pd

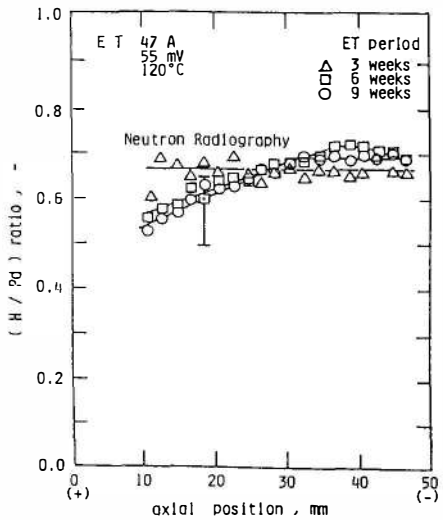

Fig.5 Relation between (H/Pd) and Axial Position in Electrotransported PdH, evaluated by Neutron Radiography