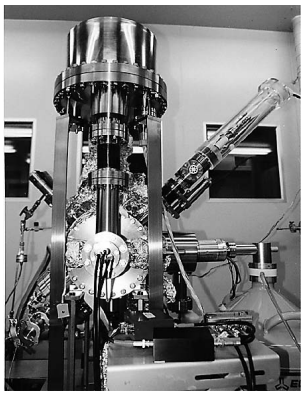

Observation of Nuclear Transmutation Induced by Deuterium Permeation through Pd Complex

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1. Introduction

Mitsubishi Heavy Industries, Ltd. (MHI) has discovered a new phenomenon of nuclear transmutation(1). When a certain element is added to a complex composed of Pd and CaO before deuterium permeated the complex, the added element transmutes into a different element after deuterium permeation.

Normally, it needs a large scale of equipment such as a nuclear reactor and an accelerator to induce nuclear transmutation, so the method of nuclear transmutation simply by inducing deuterium permeation is expected to prove a great technical and social contribution. This paper describes the observed phenomenon.

2. Experimental method

Figure 1 shows the experimental method. First one side of Pd complex (composed of a thin Pd film and a mixed layer of CaO and Pd) with an element such as Cs or Sr is filled with deuterium gas and the other side is evacuated.

Then the deuterium side of the Pd complex has the deuterium gas molecules dissociated into deuterium on the surface before getting permeated through the complex since Pd has a characteristic of allowing easy permeation of deuterium.

Here, the analysis shows that the added elements of Cs etc. get decreased with the elapse of time, while elements not existed before are detected(1).

Pd complex is formed by the following Ar ion beam sputtering method. A Pd plate 25 mm × 25 mm × 0.1 mm in size is subjected to acetone washing before being annealed at 900°C under the vacuum degree of 10^{-7} Torr or under for 10 hours.

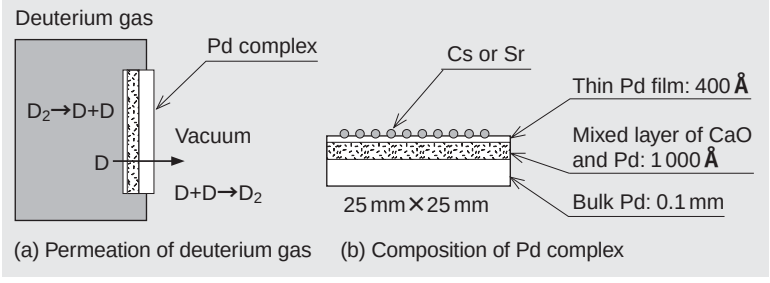

Fig. 1 Outline of experimental method

The Pd plate is subjected etching by heavy nitrohydrochloric acid before 20 A CaO and 180 A Pd are alternately deposited by using an ion beam sputtering machine to make a total 1000 A CaO/Pd complex (Fig. 1 (b)). A thin 400 A Pd film is formed on the surface.

The Pd complex is then put inside a vacuum chamber to carry out analysis of the elements on the surface by using the XPS (X-ray Photoelectron Spectrometry) unit set in the chamber. **Fig. 2** shows the outline of the experimental device. The Pd complex is laid at the center of the vacuum chamber, and the side added with Cs elements etc. is fed with 1 atmospheric pressure deuterium while the opposite side is made into vacuum by using a turbo-molecular pump. The deuterium gas gets dissociated and adsorbed to the surface of the Pd complex and gets permeated through Pd toward the vacuum side. The surface of the Pd complex is then put to analysis to observe the nuclear transmutation.

3. Experimental result

Fig. 3 shows the result of nuclear transmutation of Cs. When Cs is added to the complex and the deuterium gas is allowed to permeate, the Cs gets reduced and Pr appears on the surface instead. Although the figure shows the result of two experimental cases only, we have so far made experiments several dozens of times to confirm that Pr is detected when deuterium gas is permeated through a Pd complex added with Cs. It has been qualitatively proved that the reproducibility of nuclear transmutation from Cs to Pr is 100%.

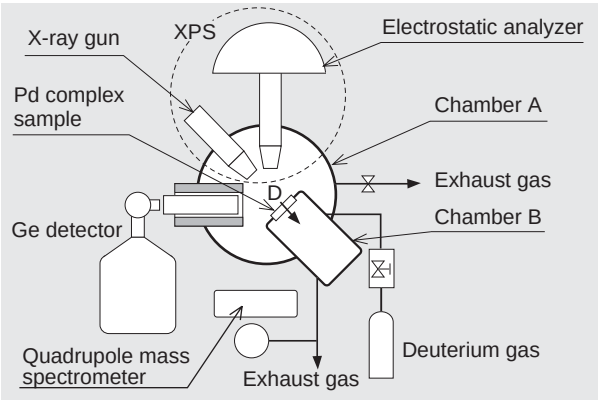

Fig. 2 Configuration of experimental device
Analysis can be carried out without taking Pd complex out.

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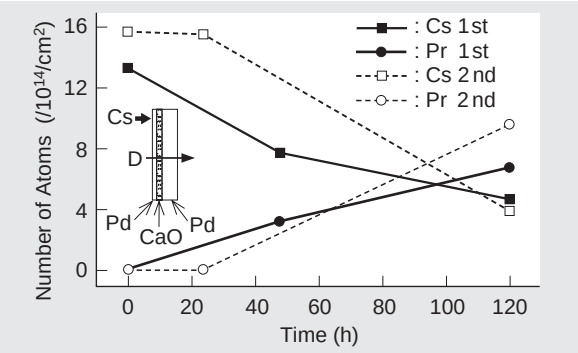

Fig. 3 Observation of nuclear transmutation from Cs to Pr
The qualitative reproducibility is almost 100%.

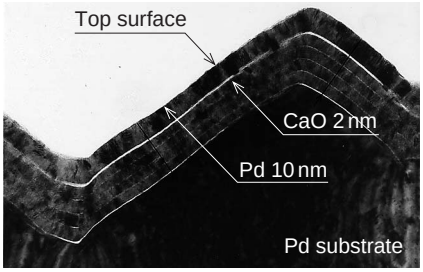

Fig. 4 Sectional photograph of Pd complex using TEM
Nano-scale structure; transmutation reaction estimated to occur within 10 nm from the surface.

The existence of Pr has also been confirmed through different other analysis methods including TOF-SIMS (Time of Flight-Secondary Ion Mass Spectrometry), XANES (X-ray Absorption Near Edge Structure), ICP-MS (Inductively Coupled Plasma Mass Spectrometry) and X-ray fluorescence analysis, etc[2]. Further, the detected Pr quantity is so much that it cannot be explained even by assuming that all impurities in the sample might be concentrated[1][2].

Fig. 4 shows the TEM (Transmission Electron Microprobe) image of the Pd complex, indicating the formation of wavy shape by the heavy nitrohydrochloric acid etching at the time of Pd complex fabricating. The white section in the figure corresponds to CaO and the black to Pd. In order to make it clear where the reaction takes place in the complex, an analysis in the depth direction was carried out by using TOF-SIMS. The results of measurement of Cs and Pr distribution in the depth direction and on the surface clearly indicated that the reaction took place in the region of about 100 A from the surface[2].

Next, Sr was added to the complex instead of Cs in order to explain that when deuterium gas was allowed to permeate, Sr got reduced with the elapse of time and Mo appeared. As shown in **Fig. 5**, similar to the case of Cs, Sr is found to get reduced and Mo detected instead. The experiment on Sr was carried out 3 times in all, with all the experimental data plotted.

Analysis of the isotopic ratio of Mo by using SIMS (Secondary Ion Mass Spectrometry) shows that the detected Mo is different from the natural Mo, with the Mo of nuclear number 96 existing in remarkably large number[1].

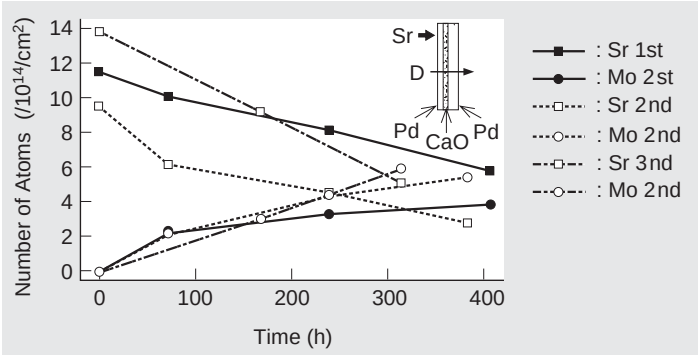

Fig. 5 Observation of nuclear transmutation from Sr to Mo
Isotopic ratio of the obtained Mo is different from that of the natural Mo, with Mo of mass number 96 remarkably large in number

This suggests that the detected Mo is not the impurities from the environment.

Finally, we would like to describe the results of several experiments made at various research and development institutes after the phenomenon was announced in the Reference Paper[1]. Professor Takahashi and his group at Osaka University made experiments using similar experimental device (apparatus) three times, each time confirming the nuclear transmutation from Cs to Pr[3]. Further, a group in Shizuoka University detected Pr through similar experiment, and Dr. Celani and his group in INFN-Frascati in Italy found nuclear transmutation from Cs to Pr, through using a different experimental method[4]. Experiments are being continued also at NRL (Naval Research Laboratory) in America to reproduce the experimental results obtained by MHI. We are planning to continue our research in the future together with Tokyo University, Tohoku University, RIKEN and others in order to explicate the mechanism.

4. Conclusions

As mentioned above, research has just started to throw light on the essentials of the phenomenon. However, we would like to explicate the mechanism and to proceed with the development program in order to foster an unprecedented and epochal technology.

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