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ANOMALOUS NUCLEAR EFFECTS IN DEUTERIUM PALLADIUM SYSTEMS

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ABSTRACT

Intense bursts of charged particles far larger than background have been reproducibly detected for the first time by using CR-39 solid state nuclear track detector during ether a high voltage discharge between deuterated palladium electrodes or a non-equilibrium out-diffusion of deuterons in palladium. No any anomalous effects were found in the control experiments of Pd-H system under the same experimental conditions. This indicates that some anomalous nuclear effects were definately produced in the Pd-D system under certain conditions.

Since Fleischman and Pons[1] and Jones et al[2] reported that nuclear fusion of deuterium occurred at room temperature in Pd or Ti cathodes during the electrolysis of heavy water(D_2O) much effort has been made to replicate or reinvestigate the possibility of cold fusion in solid matter[3].

Our calculation showed[4] that D-D fusion rate in the equilibrium Pd/D system at normal temperature will never reach the level that can be measured experimentally. It, however, is possible to produce a measurable nuclear fusion if some non-equilibrium processes were occurred in the Pd/D system spontaneously or externally.

1). One of the way to produce nonequilibrium process in Pd/D system is a high voltage discharge between deuterated Pd rods. It has been reported[5] that spontaneous neutron emissions were intermittently detected from activated Pd rods well soaked with deuterium gas by stimulasion of the Pd rods with a high voltage discharge. Here, we report a new evidence of anomalous nuclear effects in Pd/D system. A large number of nuclear tracks has been reproducibly detected for the first time by using CR-39 solid state track etch detector during the discharge experiments.

The schematic arrangement of the experimental system is shown in Fig. 1. The discharge tube is a glass tube of 35mm diameter and 400ml volume with a pair of Cu electrodes stems. The palladium(99.9%) rods of 2.5mm x 30mm were fixed to the Cu electrode stems. The purity of deuterium gas was 99.9%. The CR-39 track-etch detectors which were used to detect charged particles and neutrons were stuck to inner and outer wall of the glass tube. In order to activate the Pd rods, 5-10Kv,DC or AC,50Hz was applied between the electrodes in the vacuum of 10^{-4} torr. After the activation, the tube was filled with D_2 of 1 atm.

The activated Pd rods began to absorb the deuterium

gradually with time and the inner pressure of the tube decreased. A typical time variation of D_2 pressure in the discharge tube is shown in Fig.2. The pressure showed a few plateau region at different pressures. No obvious charged particle or neutrons were detected during the absorption process.

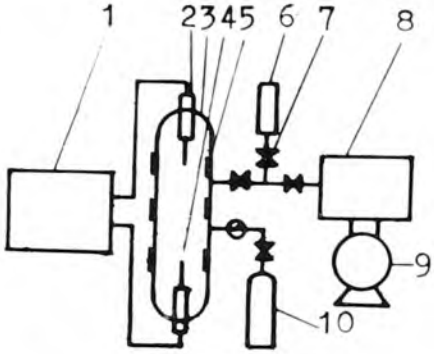


Fig.1. Schematic diagram of the experimental arrangement.
1-AC and DC high voltage supply,2-Cu stem,3-Glass tube,4-Pd rod,5-CR-39
6-Vacuum gage,7-Valves
8-Diffusion pump,9-Rotary pump,10-D_2 tank.

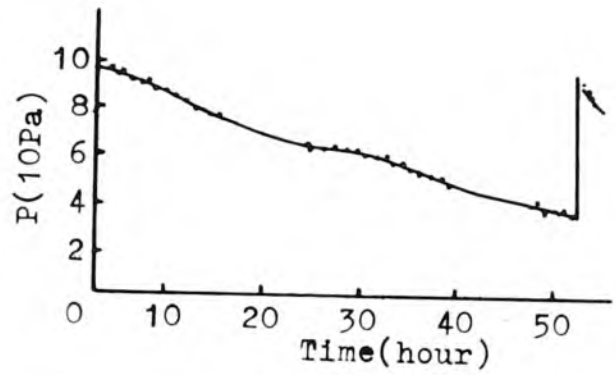


Fig.2.Time variation of D_2 pressure in the tube during the absorption process.

Stimulation of Pd rods with high voltage discharge was applied when the inner pressure of the tube was in the second plateau region after 2 to 3 days absorption. The CR-39 were then taken out and etched(6.8 mol NaOH + 4% alcohol 60°C)for 13 hours and observed in the microscope.

A photo of the nuclear tracks on the CR-39 stuck to inner wall of the tube in a typical discharge experiment is shown in Fig.3. The average number of the tracks on this CR

-39 is $\sim 2 \times 10^3/cm^2$ and $>10^5/cm^2$ in the dense region. The nuumber density of the tracks on the CR-39 stuck to outer wall of the tube is $\sim 3 \times 10^2/cm^2$, far less than one detected at the inner wall. This indicates that a large number of charged particles were produced during the discharge. In order to check the reproducibility, we conducted approximately 10 experiments with the same procedure and all showed similar results

The same experiments were performed with hydrogen gas instead of deuterium and no anomalous effects were observed . Also no any anomalous phenomina were found in the control experiments of D-Cu and D-Pd(no soaked with deuterium) systems.

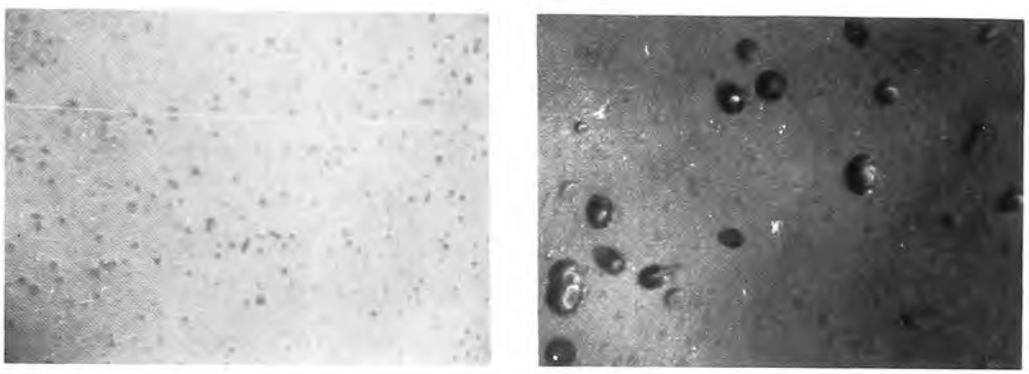
x100 x1000

Fig.3. Micrographs of the tracks of charged particles on the CR-39 in one of the typical discharge experiment of the Pd/D system.

2). The other way to induce non-equilibrium process in Pd/D system is a controlled out-diffusion of deuterons in palladium developed by Yamaguchi and Nishioka. They reported that[6] a gigantic neutron burst of $(1-2) \times 10^6/s$ had been detected from deuterated Pd plates with hetrostructures set in a vacuum chamber. We attempted to look for charged particle reaction products in the similar experiment and a large number of nuclear tracks have been reproducibly detected by using CR-39.

In our experiment, a 10nm layer of Mn and O was deposited on one of surface of a pure Pd film(10mm x 10mm,thi-

ckness=.09mm) and the film was loaded with D_2 gas(99.9%,10^5 Pa) for 24 to 48 hours. A 100nm thick of Au film eas then deposited on the other surface of the Pd film. A CR-39 detector was stuck to Mn-O film side and the sample was then placed in a stainless-steel chamber and evacuated to 10^{-3} Pa. After about two hours, the sample was taken out and etched. A photo of nuclear tracks on the CR-39 is shown in Fig.4. The average number density of the tracks is $\sim 3 \times 10^3$/ /cm^2 and $> 5 \times 10^5/cm^2$ in the dense region. No any anomalous effects were found in the control experiment of Pd-H system.



x100 x400

Fig.4. Micrographs of the tracks of charged particles on the CR-39 in one of the noneq-uilibrium out-diffusion experiment.

We coclude that some anomalous nuclear effects were definately occurred in the Pd/D systems during a high voltage discharge or a non-equilibrium out-diffusion processes.

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