On the products of nucleus reactions formed during deuterium diffusion through palladium membrane

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Abstract. We report on the results of experimental observation of interaction of deuterons in a palladium membrane in deuterium gas under the pressure of **P**=0,07 Mpa. The temperature fluctuation with an amplitude of $\Delta T = 4 \div 5^0$ C was observed. After a 42 hour experiment, a significant increase in the number of of tritium (^3T) atoms, **N**>10^9, has been revealed, while no traces of ^4He have been found.

Introduction. The results of the investigation of cold nuclear fusion by M. Fleischmann and S. Pons published in 1989 [1] are not accepted by scientific community until now because of rather small amount of products of nucleus reactions and difficulties with reproduction of their experimental results in other laboratories. The aim of our work is to develop experimental equipment capable of synthesizing essential amount of such products. Our idea is based on the assumption that the composition and the structure of the material saturated by deuterium may have an essential influence on the processes occurring in the solid body at low energy reactions. On our opinion, the intrinsic properties of the metallic matrix determine not only the ability of the material to accumulate deuterium but also the possibility for deuterium nucleus to move and interact.

In our work [2] we have reported on the results of deformation of titanium saturated with deuterium and on the process of saturation. It was concluded that the results depend on the initial structure of the sample. On the basis of the analysis of our results and the results available in the literature, we have proposed a mechanism of nuclear fusion via tritium channel [3].

To confirm the proposed mechanism one should carry out an experiment on generation of a large number of products of low energy reactions. Our experimental setup is based on the following prerequisites:

1. the synthesis of cold fusion products should be continuous,
2. the experiments should be performed at high temperature in order to increase the rate of deuterium diffusion,
3. it is necessary to provide a directed motion of deuterium through metal.

The simplest possibility to satisfy all three conditions is to conduct the experiment in the gaseous atmosphere of deuterium. Since the process takes place at the metal surface [4], the reaction should be facilitated during deuterium diffusion through a membrane. The directed motion can be achieved by a glow discharge at one side of the membrane.

Experimental procedure. In Fig. 1, the experimental equipment is schematically shown.

Fig. 1. Schematic of the experimental equipment: 1 reaction chamber, 2 ceramic tube, 3 nichrome curl of the furnace, 4 stainless steel cylinder, 5 Pd membrane, 6 high voltage vacuum feedthrough, 7 anode, 8 low voltage vacuum feedthrough, 9 control thermocouple, 10 measuring thermocouple, 11 adjustable power supply of the furnace, 12 adapter, 13 computer.

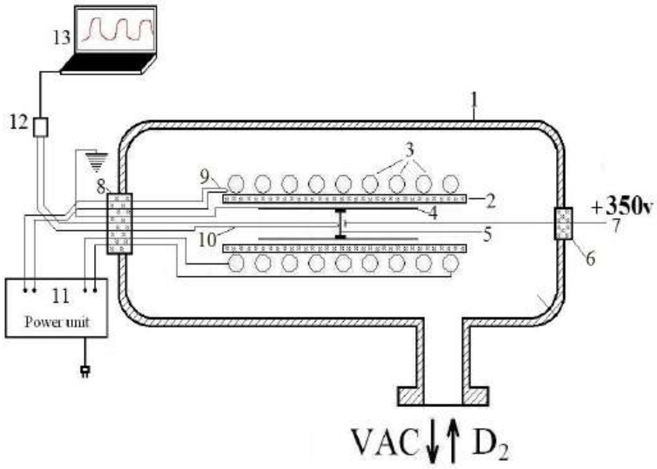

Fig. 1 Schema of experimental chamber

The structure of a palladium foil (Pd -99,8) having thickness of s = 0.1 mm was processed in accordance with the principles developed in [2]. The disk type membrane was sealed in the tube made of stainless steel. The induction furnace provides heating of the tube up to T=700^{0}C. After vacuumization of the reactionary volume, it was filled with deuterium under P<0,07 MPa. Glowing discharge was applied (DC), (I=40 ma, U=350 v).

Mass-spectrometric analysis of gas content before and after the process was made on the mass-spectrometer “Thermo Finnigan MAT 95 XP” (the resolution R=10000, the scanning range of mass numbers 1 – 18, the ionization energy 70 eV).

The concentration of tritium was measured by a scintillation method according to the procedure described earlier [2].

For the level of neutrons and gamma-quanta measurement a spectroscopic radiometer SRPS-2 was used. The threshold level of neutrons $N_{\text{пн}}$ = 30±2 1/50 sec and gamma-quanta $N_{\text{пг}}$ = 700±15 1/5 sec was not exceeded during the experiment.

Experimental results. Temperature in the vicinity of the membrane was recorded constantly and it is shown in Fig. 2. It can be seen that after two hours the temperature starts to fluctuate, while the discharge current remains constant.

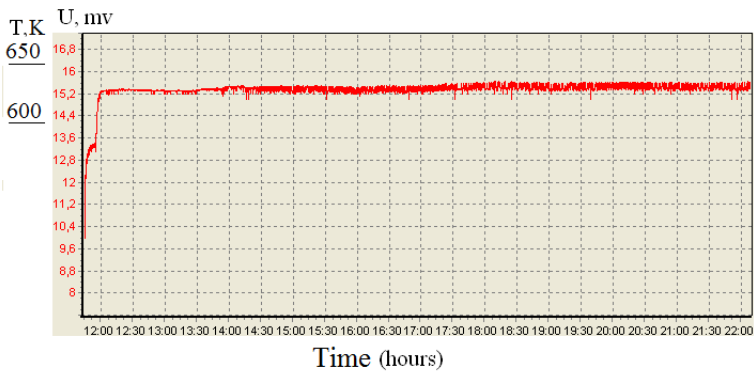

Fig.2 Change in temperature near the membrane

Fig. 3 shows temperature fluctuations in an increased scale. The fluctuations are not stable since the duration of intervals with relatively small and relatively large temperature change. The presence of temperature fluctuations can be explained in terms of the model of low temperature fusion due to resonant transfer of neutron from deuteron proposed in [3]. Deuterons are accumulated in the vicinity of the membrane surface. Afterwards they move to the structure defects and form pairs of quasi-ions D_2^+. During this process the internal stresses grow in the membrane. When these stresses attain certain value, the quasi-ions leave the metal interior and move in the field of a crystal lattice. There occurs a resonant transfer of neutron from one deuteron to another, resulting in formation of proton and triton nuclei accompanied by heat emission. Since a large number of deuteron pairs participate in this reaction, the temperature fluctuations can be detected even by a thermocouple. When internal stresses are decreased the motion of deuterium pairs ceases, high thermal conductivity of hydrogen isotope gas results in sharp cooling and the temperature of the membrane decreases. Then the process repeats.

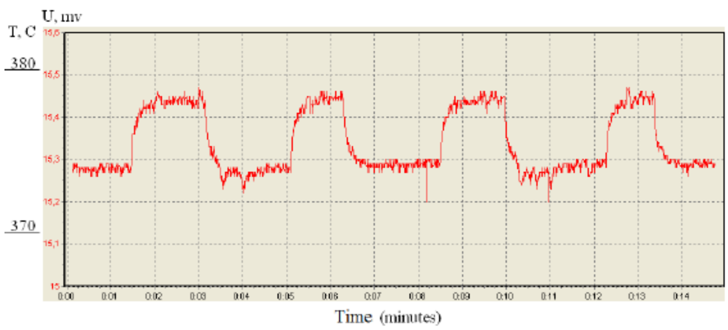

Fig. 3 Fluctuation of temperature after t=36 hours of discharge applied

The process was stopped after t = 42 hour. A part of gas (**v**=100 ml) was collected in metallic vessel and then analyzed by a mass-spectrometer. The remaining gas was absorbed by Ti powder (m=3 g) to analyze for tritium.

The quadrivalent helium was not detected. The amount of ^{4}He was on the background level.

During the experiment, the neutron and gamma quanta did not exceeding the background level. Tritium was measured by scintillation method, and the total amount was N>10^{9} atoms.

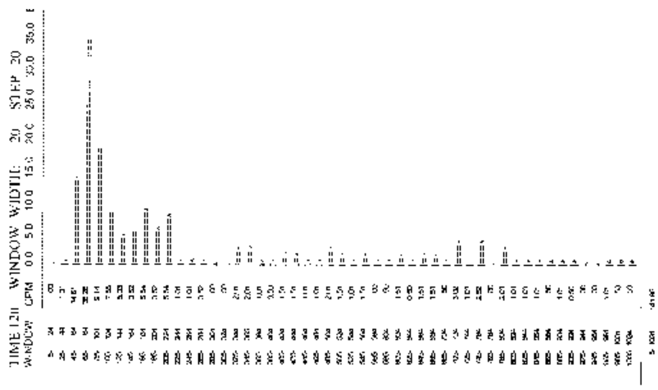

Fig.4 Energy spectrum of tritium solution

Conclusions. A device producing heat and tritium was proposed.

Temperature fluctuations with the amplitude of ΔT=4-5^{0} C were recorded.

The essential increase in the amount of tritium, N>10^{9} atoms, was registered.

It was shown that the low temperature reaction in deuterium medium occurs via the tritium channel.

References

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