SEARCH FOR THE UPPER LIMIT FOR THE STIMULATED D + D NUCLEAR FUSION IN METALLIC DEUTERIDE

S. Blagus, M. Bogovac, D. Hodko, M. Krčmar, Đ. Miljanić, P. Tomaš and M. Vuković

Ruđer Bošković Institute, 41000 Zagreb, P.O.B. 1016, Yugoslavia

ABSTRACT

An attempt to estimate neutron yield from the catalytic $D(d,n)^3He$ fusion reaction in PdD_x and TiD_x lattice has been made during the electrolysis of $LiOH/D_2O$ solution using Pd and Ti cathodes. The foreground and background measurements data during the long term electrolysis showed no evidence of the stimulated d+d fusion nuclear reaction. The upper limit of neutron emission was 0.01 and 0.004 neutrons per second per gram of the Pd and Ti cathodes, respectively.

1. INTRODUCTION

It has been reported that electrochemically induced fusion in condensed matter has been observed (1,2,3). Very low neutron yield of S. Jones et al. (2) has been supported by the measurement under the Gran Sasso massif (3). The measurements of neutron emission of Ti plus D_2 gas have been reported by H.O. Menlove et al. (4), and by De Ninno et al. (5).

2. ELECTROLYSIS AND NEUTRON DETECTOR

The electrolytic cell consisted of three compartments: a cathode, an anode, and a reference electrode. The 99.7% D_2O with 0.1 M LiOH electrolyte was used. A detailed description of the measuremet performed on Pd electrolytic cell was given elsewhere (6,7,8). Different masses, volumes, area to volume ratios, shapes, and sizes of the cathode were used. The cathode of 1.7 g was palladium sheet of 7x2 cm and 0.11 mm thick. The other three electrodes were argon arc casted palladium (99%) pellets of 1 g, 14 g, and 27 g. Current densities were controlled galvanostatically. An attempt has been made to achieve various dynamic

conditions of the forced deuterium sorption/desorption in Pd. They included successive changes from anodic to cathodic potentiostatic and open circuit desorption of deuterium with frequencies of 2.0 Hz, 2.2 mHz, and 0.56 mHz. During the long term electrolysis a thin layer of Pt at the Pd cathode surface was found by XRFS.

The ^{6}Li glass scintillator neutron counter consisted of 2 mm ^{6}Li doped glass scintilator (5.12 and 12.8 cm in diameter) coupled by a light guide to a photomultiplier. The NE 912 scintillator was 98% opaque to thermal neutrons which were detected by the $^{6}Li(n,t)^{4}He$ reaction. In the present experiment a 5 cm thick polyethilene moderator was selected to optimize the sensitivity to 2.45 MeV neutrons. The experiment was carried out in an underground laboratory with 0.2 m concrete deck covered by 3.0 meters of soil. The ^{6}Li glass detector was well shielded by lead. The neutron counter efficiency was 0.5%. The $^{6}LiI(Eu)$ crystal neutron detector has been used as a control monitor.

Another set of measurements was performed with electrolytic cell consisting of Ti cathode surrounded by Pd sheet as an anode. During the electrolysis the small amount of palladium was anodically dissolved and codeposited on the Ti cathode. Therefore it was possible to make measurements in the conditions of thin Pd layer on the massive 28 g Ti electrode. Codeposition was found by XRFS.

3. RESULTS AND UPPER LIMIT FUSION RATE ESTIMATE

Data for many foreground and background measurements have been analyzed. After each measurement the ^{252}Cf neutron source was used to check stability of the counting system. A structure was observed between channel 60 and 80 in foreground and background measurements which correspond to the expected neutron peak region from cosmic ray and natural background induced processes. In the difference pulse spectra obtained with and without electrolysis it could be observed only statistical and other fluctuations and that is no net effect in the expected neutron peak region.

The upper limit for the neutron yield from the cell with 27 g Pd pellet was 0.01 neutron/s per gram of palladium, during the measurement time of 5.64×10^{5} s. In the case of the Ti cathode during the measurement time of 1.3×10^{6} s, the upper limit of the neutron yield was 0.004 neutron/s per gram. Assuming the atomic concentration of deuterons per atom in Pd lattice as 0.7 (2 deuterons per atom in Ti lattice),

one can estimate the fusion rate as $4x10^{-24}$ ($3x10^{-25}$) fusion per deuteron pair per second.

The measurements of tritium concentration in pure D_2O or H_2O samples in electrolytes before and after electrolysis, and in pure water exposed to the laboratory atmosphere, for different periods of time, have been carried out by liquid scintillation counter. The relatively high tritium concentration has been explained by the high rate of exchange processes in the laboratory, high enrichment ratio in D_2O, and isotopic enrichment by evaporation, diffusion and chemiluminiscence processes.

The experiment with TiD_x metal-gas system was also carried out at liquid nitrogen temperature under the pressure of 10^7 Pa. In the preliminary experiment it was realized that cooling down to liquid N_2 temperature in the vicinity of the ^6Li glass scintillator affects the efficiency of the scintillator and its stability. The position of the ^{252}Cf peak has been shifted.

REFERENCES

1. Fleishmann, M., Pons, S.: J. Electroanal. Chem. 261(1989)301.
2. Jones, S.E., Palmer, E.P., Czirr, J.B., Decker, D.L., Jensen, C.L., Thorne, J.M., Taylor, S.F., Rafelski, J.: Nature 338(1989)737.
3. Bertin, A., Bruschi, M., Capponi, M., De Castro, S., Marconi, U., Moroni, C., Piccinini, M., Semprini-Cesari, N., Trombini, A., Vitale, A., Zoccoli, A., Czirr, J.B., Jensen, G.L., Jones, S.E., and Palmer, E.P.: Experimental evidence for cold nuclear fusion in a measurement under the Gran Sasso massif, Workshop on Cold Fusion Phenomena, May 1989, Santa Fe.
4. Menlove, H.O., Fowler, M.M., Garcia, E., Mayer, A., Miller, M.C., Ryan, R.R. and Jones, S.E.: The measurement of neutron emission from Ti plus D_2 gas, ibid.
5. De Ninno, A., Fratolillo, A., Lollobattista, G., Martinis, L., Martone, M., Mori, L., Podda, S., Scaramuzzi, F.: Neutron emission from a Ti-D system, ibid.
6. Tomaš, P., Blagus, S., Bogovac, M., Hodko, D., Krčmar, M., Miljanić, Đ., Vajić, M., and Vuković, M.: An attempt to detect catalytic nuclear fusion in PdD_x lattice, ibid.
7. Tomaš, P., Blagus, S., Bogovac, M., Hodko, D., Krčmar, M., Miljanić, Đ., Vajić, M., and Vuković, M.: Fizika 21(1989)209.
8. Blagus, S., Bogovac, M., Hodko, D., Krčmar, M., Miljanić, Đ., Tomaš, P., Vajić, M. and Vuković, M.: Z. Physik A, Atom. Nucl. 333 (1989)321.