Conference Proceedings Vol. 33
«The Science of Cold Fusion»
T. Bressani, E. Del Giudice and G. Preparata (Eds.)
SIF, Bologna 1991

FUSION NEUTRON EMISSION INDUCED BY INJECTION OF DEUTERIUM INTO TITANNIUM TARGET IN A MIRROR PLASMA

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ABSTRACT

A target, titannium sheet laden with deuterium, is immersed in the deuterium plasma confined in MM-2U magnetic mirror and it is biased at about -10 kv. The deuterium nuclei-deutrons are infused into the crystal structure of titannium target. After having implanted deuterium for several hours, random neutron emissions are observed and neutron bursts are measured by using two identical BF-3 neutron detectors No.1 and No.2 located at different positions and a neutron dosemeter.The neutron count rates are up to 100 times higher than the background count rate of 0.8 count/sec. It is corresponding to neutron flux of (2-8)E+5 neutron/sec. No gamma-ray counts beyond background are detected in our experiments. It is suggested that random neutron bursts may be from cold nuclear fusion reactions related to the propagation of microcracks of the metal lattice.

I INTRODUCTION

The "COLD FUSION" announced by professors Martin Fleischmann and Stanley Pons on March 23,1989 [1] evoked great excitement and stimulated many scientists to repeat their results. The cold fusion phenomenon has been demonstrated in collaborative experiments at Brigham Young University and at other laboratories. Current efforts focus on trying to understand and control (or repeat) this cold fusion phenomenon.

Just as pointed out by S.E.Jones[2], non-equilibrium states of the deuterium-metal (D-Ti or D-Pd) system are essential conditions for creating cold fusion reaction. As we know, electrolysis is one way to produce states which are far from equilibrium. The other ways, such as varying external parameters of a system, temperature, pressure and contact potential, etc. will also generate non--equilibrium states of a system. Implantation of deuterium ions into the metals is one of the effective methods for generating a non-equilibrium state. Based on this idea we started our experiments since April,1989. The recent results of fusion neutron emission induced by infusion of deuterium into a titannium target in a simple mirror machine MM-2U are presented here.

II EXPERIMENTAL APPARATUS AND ARRANGEMENT

MM-2U is simple mirror device, mirror ratio is 2:1, spacing between two mirrors is 0.8 M andcentral magnetic field strength is 500 G. After pumping to pressure of 1E-4 Pa the pure deuterium is poured into the device to ambient pressure of 5E-2 Pa. An electron beam with current of 6mA and energy of 1 kev is injected into the device along the axis.The deuterium plasma parameters obtained are : electron density Ne=5E+9 cm-3 and ion temperature Ti=1 ev.

A titanium plateof 2*4 cm+2 as a target is inserted into the deuterium plasma at the central plane of the device and is perpendicular to the magnetic field lines. A high negative voltage about 10-20 kv is exerted on the target to obtain the infusion of deuterium. As the target is at the negative potential, an ion sheath around it must be formed.The deuterium ions entered into the sheath will be accellerated to bombard the Ti-target and to be implanted into it at once (see Fig.1).

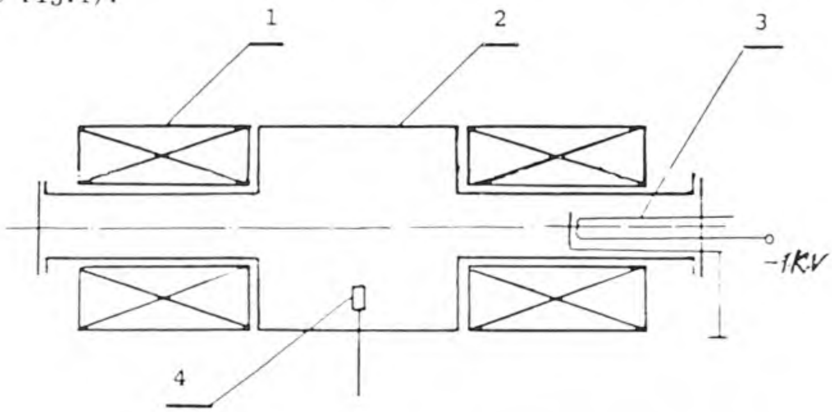


Fig.1 The diagram of the experimental device
1--coil 2--vacuum vessel
3--electron gun 4--Ti-target

We use two identical BF-3 neutron detectors No.1 and No.2 located at different positions and a neutron dosemeter to detect the fusion neutrons and a NaI(Tl) crystal scintillation counter to monitor the gamma--ray emission (see Fig.2). The detectors are calibrated by a Ra--Be neutron source and Cs-137 radiation source, respectively. The calibration curve is shown in Fig.3.

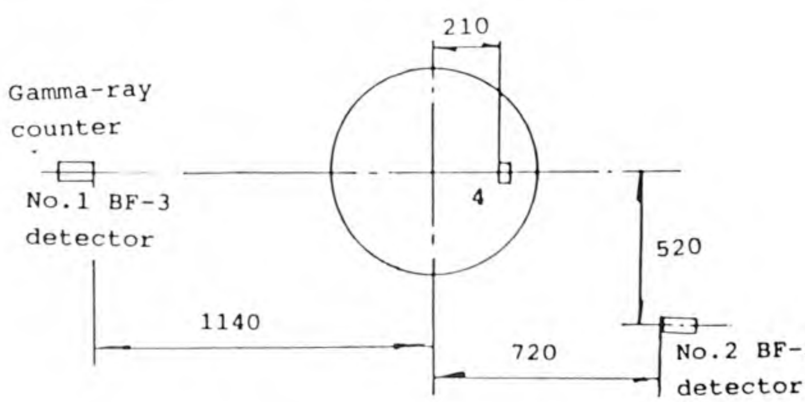


Fig.2 Arrangement of the detectors

III THE EXPERIMENTAL RESULTS

The experiments last for 30 days and some results obtained are as follows:

(1) The electron beam current is 3 mA, electron energy is 1 kev, negative voltage on the target is 8-10 kv. After having implanted deuterium for nine hours, the burst neutron emission is observed and lasts for 2-3 min.. The neutron count rate is corresponding to 9.5E+4 neutron/sec (see Fig.4-1).

(2) The implanting deuterium conditions are ditto. Three hours later, the burst neutron signal appears and its count rate is corresponding to 6.5E+5 neutron/sec. The duration of neutron emission is about 10 min. (see Fig.4-2).

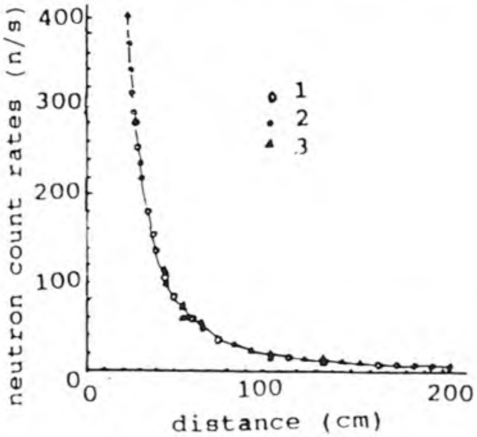


Fig.3 The calibration curve of BF-3 detectors
1--calculated value
2- and 3- show the count rates collected by No.1 and No.2 detectors, respectively.

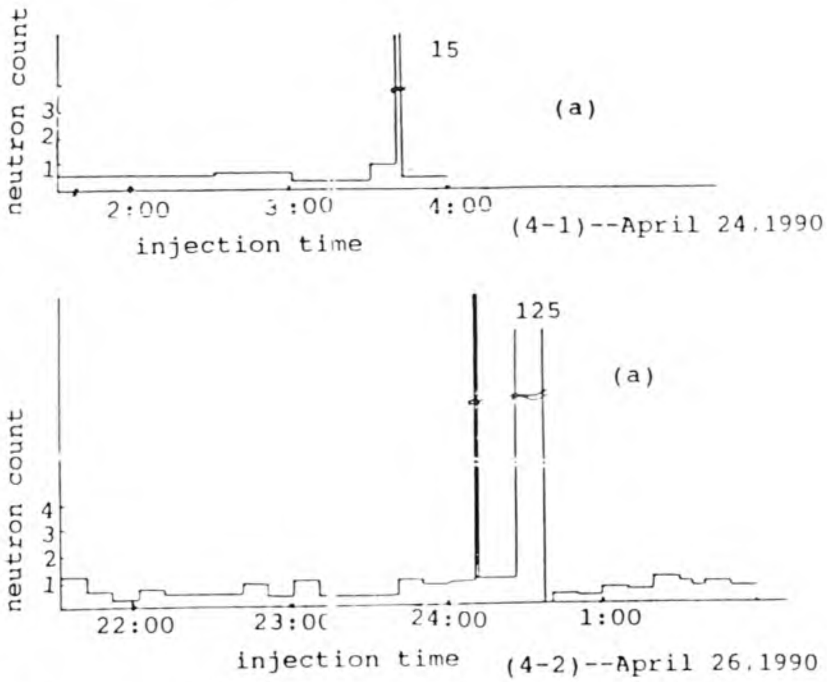
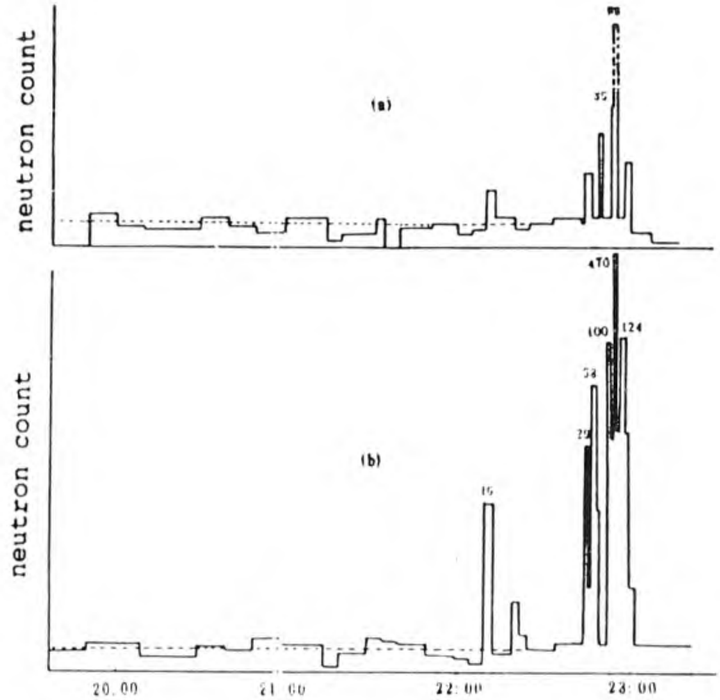


Fig.4 Variation of neutron count rates with the time of deuterium injection
The dashed line indicates the average background rates, it's about 0.8 count/sec
(a) and (b) show the results measured by the No.1 and No.2 detectors, respectively.

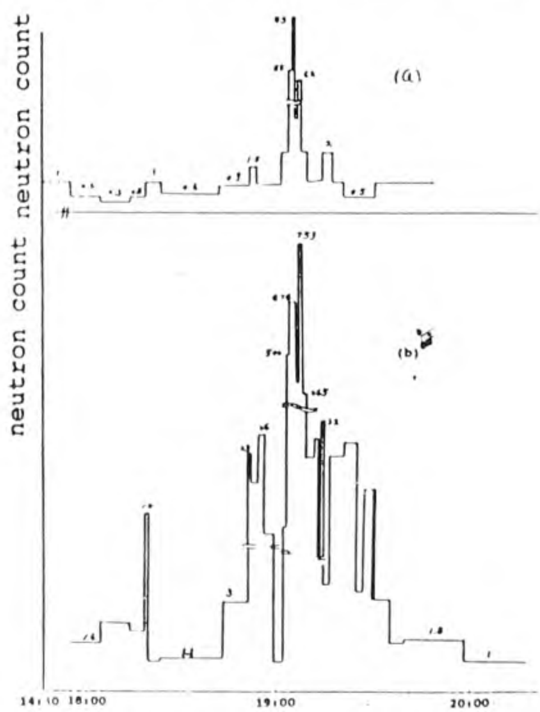
(3) Implanting deuterium ions for three hours, the count rates of No.1 and

No.2 detectors are corresponding to 5E+5 and (1-5)E+5 neutron/sec, respectively. They are shown in Fig.4-3



injection time (4-3)--April 29,1990

(4) After having implanted deuterium for three and a half hours, the BF-3 counters show the peaks of count.(See Fig.4-4). The No.1 and No.2 detector count



injection time (4-4)--April 30,1990

are corresponding to 5E+5 and 8E+5 neutron/sec. respectively.

(5) In above mentioned experiments, we have never detected gamma--ray count beyond background level.

During the experiments, we change parameters of electron beam, target voltage and ambient pressure etc. to observe the variation of neutron emission. As a result, the higher the parameters the more easily the neutron emission is induced. Once the neutron bursts, its count rate will be very high and then will come back to the background level immediately no matter whether the parameters of operation are still to be maintained at the original value.

IV DISCUSSION AND CONCLUSION

The neutron signals obtained in our observation are different from the neutron sighals obtained by beam--target intereactions.

The discussion is as follows:

When the high negative voltage is held at the target the backgroound count rate is 0.8 neutron/sec which is corresponding to (1-5)E+4 neutron/sec. But when the high negative voltage is removed from the target, the background count rate decreases to 0.5 neutron/sec. So we can consider the neutron count coming from beam-target reaction. The beam--target intereaction has certain relation between neutron signals and beam current and energy. In our measurements, the neutron bursts are uncertain in creating time and count rate. The neutron burst can only be observed after deuterium is injected for several hours,i.e. deuterium infused into the Ti-target is accumulated to a certain level. Thus a conclusion can be drawn that "fusion" can be induced only at the deuterium (or deutron) in the lattice reaches a certain level. Then the neutron emission characteristic of existance of nuclear fusion can be detected.

REFERENCE

[1] M. Fleischmann, S. Pons and M. Hawkins, J.Electronal.Chem., 261,P.301,(1989)

[2] S.E. Jones et.al., Nature, 338,P.737(1989)