Raj, P., et al., *Search for Nuclear Fusion in Gas Phase Deuteriding of Titanium Metal*, in *BARC Studies in Cold Fusion*, P.K. Iyengar and M. Srinivasan, Editors. 1989, Atomic Energy Commission: Bombay. p. B 1.

SEARCH FOR NUCLEAR FUSION IN GAS PHASE DEUTERIDING OF TITANIUM METAL

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Introduction

The possibility of D-D nuclear fusion in some deuterium-metal systems, under ambient conditions, has aroused feverish worldwide interest. Most of the work reported, so far, concerns deuterium charging of Pd metal through electrolysis of D_2O.

In the Chemistry Division, we have carried out some experiments on the deuteriding behaviour of Ti metal, through gaseous route, in the absorption as well as desorption modes, with the view to look for the fusion products, neutrons in the present case. These kinds of experiments have been reported by Frascatti Group in Italy[1]. These authors detected neutron emission lasting over a period of several hours.

Experiments

The experimental arrangement for deuteriding Ti metal is shown in Fig. 1, which is self-explanatory. This set up has been routinely used for high pressure hydriding studies on several systems, reported by us[2-4]. In some of the experiments reported here, deuterium pressure was cycled between high and low values by simply changing the temperature of the cell housing the sample. Most of the experiments were done in the desorption mode. Ti metal pieces (cut from a sheet) were surface cleaned and subjected to activation treatment before D_2 loading and subsequent desorption treatment etc.

The neutron counting set up consists of an array of 24 He^3 counters arranged in a well like geometry. These counters (each 50 cm in length 2.5 cm in diameter and filled with He^3 at 4 atm.) housed in paraffin moderators, are all connected in parallel to a single pre-amplifier. The counting efficiency of this system was found to be $\approx$10%. The counts are recorded in 8192 channel multi-scalers. In the experiments reported here dwell time of 40 sec. was fixed, so that each point in Fig. 2(a) to (d) represents the number of counts per 40 sec. The background counts collected for about 10 days, before the start of these deuteriding experiments, was found to be quite steady 60 counts/ 40 secs. This background count rate continues to be the same well after our experiments.

Results

In the first set of experiments, starting from 3rd June 1989, after activating Ti metal pieces, D_2 gas was contacted with the sample at a pressure ~10 atm. while keeping the sample at low temperature (~77K). After a soaking time of ~20 min., sample temperature was raised gradually, while simultaneous evacuation was started. Within about 15 min. the neutron counter registered an increase in count rate reaching a max. 3900 (as compared to background counts of ~60), see Fig. 2(a). On withdrawing the reactor from the counting well, a considerable reduction in the counts was observed. On re-introducing the reactor after background counts are restored, an additional peak like structure was observed. Although the evacuation was continued, no further increase in count rate over the background could be observed over the next twenty hours.

The next experiment on the same charge was carried out by repeating the conditions of the first experiment. The results of this experiment, dated 4th June 1989, are shown in Fig. 2(b). Again two peak like structures, each lasting for about 30 min. and separated by 50 min. were seen. However, the intensities of both these structures are greatly reduced, as compared to the first experiment (3rd June 1989), the max. counts being ~700.

In the third experiment, with the same charge of Ti pieces, D_2 gas pressure was made to cycle between ~50 atm. to ~13 atm. by changing the reactor temperature from room temperature to 77 K. In this case large changes in counts, as a function of time were noticed. An increasing trend of counts initiated at ~2330 hrs on 4th June 1989 lasted for almost 7 hrs. with an estimated integral counts ~6.5×10^5. Even after this long bursts like structures, some additional peaks were observed on 5th June 1989. With no further structures observed over the next few hours, desorption was carried out after loading the sample with D_2 gas with the sample temperature at ~77K. By raising sample temperature gradually, while simultaneously evacuating, a much bigger structure lasting for ~2 hrs. (from ~1830 to 2030 hrs. on 7th June 1989) was seen Fig. 2(c). An approximate estimate of integrated count over this period is 7×10^5. Further experiments with this charge, involving D_2 loading followed by prolonged periods of evacuation at temperature up to a max. of ~200°C, did not show further structures.

A second series of similar experiments on a fresh charge of Ti from the same source did not exhibit exactly similar behaviour, as found for the first charge. However, one set of experiments on 17th June 1989 see Fig. 2(d) involving pressure cycling, followed by evacuation, exhibited increase in count rate lasting over a period of ~100 min. In this case, the scatter in the counts was found to be rather large and maximum counts up to 10^5/ 40 s were observed, as compared to background count of ~60/ 40 sec. This charge showed no further increase in count rate even after various treatments.

Further experiments are planned — (i) to study all possible parameters relating to the observed increase in the count rates, (ii) to identify the source of these extra counts, and (iii) to investigate the energy and time structure of the radiation responsible for the observed peak like structures.

Acknowledgement

The authors are indebted to Dr. R.M. Iyer, Director, Chemical group and Dr. J.P. Mittal, Head, Chemistry Division for helpful discussions and encouragement. Sincere thanks are due to Dr. P.R. Natarajan, Head, Radiochemistry Division; Dr. H.K. Sadhukhan, Head, Heavy Water Division; Dr. C.K. Gupta, Head, Metallurgy Division and their colleagues for providing neutron counting facility, Deuterium gas and Titanium metal, respectively.

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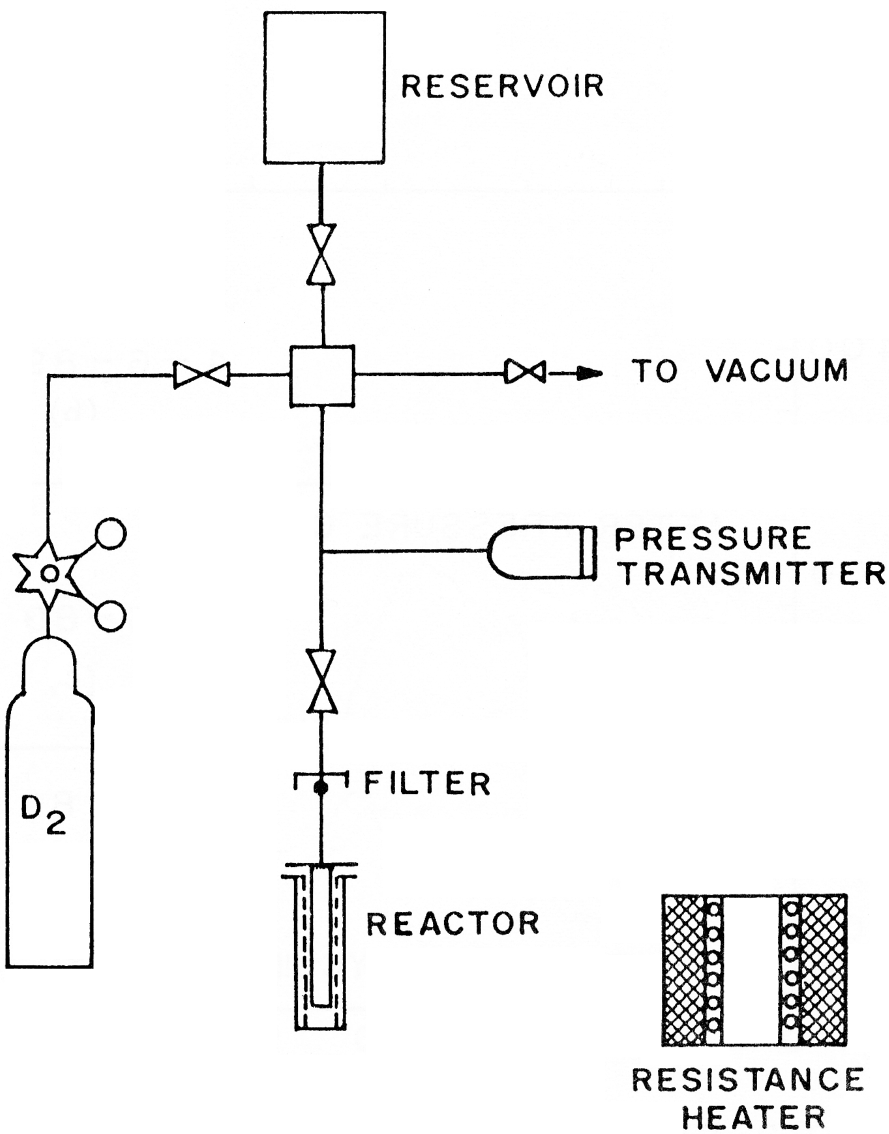

Fig. 1. Schematic diagram of the hydriding/dehydriding unit

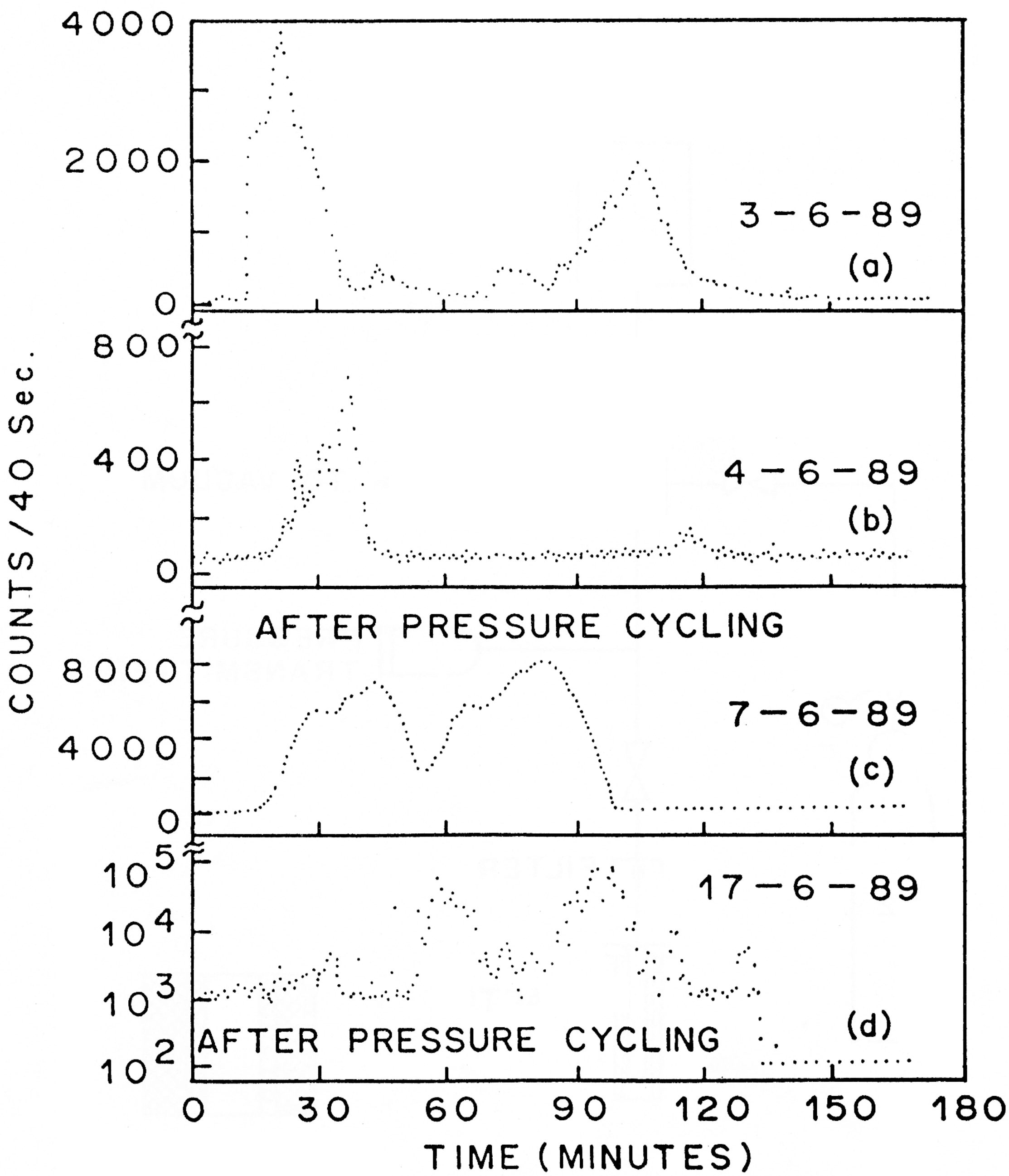

Fig. 2. Desorption mode experiments