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OBSERVATION OF COLD FUSION IN A Ti-SS ELECTROLYTIC CELL

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Introduction

Since the two communications[1-2] reporting the occurrence of cold fusion, experiments had been initiated in a number of laboratories to study the electrolysis of D_2O with palladium (Pd) as cathode. In a few cases titanium (Ti) has also been used as cathode. Ti is a material of interest as it can form deuteride up to the composition of TiD_2 (against 0.6 in case of Pd). Further Ti is more easily available and cheaper in our country. Three groups[3-5] have reported the use of Ti as the cathode material in their electrolytic experiments. Meanwhile in an interesting paper[6] use of Ti in deuterium gas loading experiments has been reported wherein occurrence of neutron bursts under non-equilibrium conditions was observed.

Having obtained very encouraging neutron and tritium yields with electrolytically loaded Pd[7], it was decided to investigate Ti as cathode material in the electrolysis of D_2O. The results of both neutron and tritium measurements are reported in this paper. Unlike the Pd-Ni cell described in paper A1 which was a diffusion type commercial hydrogen generator, the Ti electrolytic cell employed for this work was of very simple design and constructed from materials readily available.

Description of the Cell

A schematic sketch of the cell is shown in Fig. 1. A cylindrical rod of Ti of dia 22 mm and length 150 mm constituted the cathode (area 104 cm^2) while an SS outer tube of 4 cm ID served as the anode. The two electrodes are fixed coaxially with PTFE spacers and gaskets as shown in the figure. The inter electrode gap is 9 mm (surface to surface). As the cell does not have provision for separating deuterium and oxygen, both these gases are vented out from the top. The cell is also equipped with a thermowell to measure the temperature of the electrolyte. 5M solution of sodium deuteroxide (NaOD) in heavy water (isotopic purity > 99.8%) was used as the electrolyte, to achieve high current density. An external DC power supply was employed. The salient features of this electrolyzer are summarised in Table I.

Operation of the Cell

The electrolytic cell was first operated with 5M NaOD in D_2O for about 8 hours. Only temperature increase was recorded for this run. The current was raised slowly from 20 A (current density 193 mA/cm^2) to a maximum of about 40 A (current density of ~ 400 mA/cm^2). The cell was then drained, flushed with distilled water several times, and operated for 12 hours with an electrolyte of 5 M NaOH in H_2O. By this time the neutron monitors were installed in position.

Subsequently it was cleaned, rinsed and a repeat run with 5 M NaOD in D_2O was conducted. As this cell does not have provision for automatic electrolyte feed, the electrolysis was carried out as a batch process. After a few hours of operation, when the electrolyte level had decreased considerably, fresh electrolyte was added to make up the volume. The cell had operated for 8 hours, when the cathode was found to have attained a dull black coating which when analysed chemically was found to contain iron as major component. The electrolyte solution also developed a pale greenish yellow colour because of dissolution of Fe from the anode. The cell is therefore being modified to have both anode and cathode of titanium. In addition the inter electrode distance between anode and cathode is being reduced to attain larger current densities.

Neutron Measurements

A bank of three He^3 counters embedded in paraffin moderator and a plastic scintillation detector were employed for neutron measurements. Efficiency of the He^3 detector viewing the cell was ~ 1%. The plastic scintillator which was placed away from the cell was employed as a background monitor. Background data was first collected before electrolysis was commenced. The background counts in the He^3 channel was ≈ 240 counts per 10 seconds. Neutron measurements carried out with the cell operating with NaOH-H_2O as electrolyte was similar to the background data. But when the cell was operated with NaOD-D_2O as electrolyte, after about 3 hours the level of the neutron counts was higher (~ 590 counts per 10 sec.). No big bursts of neutrons were observed as in the case of Pd-Ni electrolyser[7]. When higher counts were continuously indicated, the cell was put off and the neutron counts was observed to come down immediately but it was still above background (~ 385 counts per 10 sec.). The experiment was finally terminated when the counts level reverted to background presumably due to fouling of cathode surface by iron deposit. Fig. 2 shows a representative plot of the data (for 10 min before and 5 min after switching off) showing the typical drop in the neutron counts when the cell was switched off. The typical background counts when the cell was removed is also indicated in the figure for comparison.

Tritium Measurements

At the end of about 8 hours of electrolysis when the electrolyte was sampled and analysed for tritium content it was found to contain ~ 48 nCi/ml of tritium activity. This is almost three orders of magnitude higher than the tritium level of the stock heavy water used for preparing the electrolytic solution which was ~ 0.05 nCi/ml. The tritium level in the electrolyte after about 12 hours of operation with NaOH was only 0.0676 nCi/ml.

Conclusions

The results of the neutron and tritium measurements seem to strongly indicate that cold fusion occurs in the Ti-D system also. When compared with Pd-D systems where big neutron bursts are observed, in the present system the neutrons are produced at a low but more or less steady rate. It is estimated from the neutron counts data, the duration of cell operation (the integrated time for which the cell was active was approximately 150 minutes) and the efficiency of neutron detectors (1%) that in all about ~ 3×10^7 neutrons had been generated. The terminal tritium level in the electrolyte was ~ 48 nCi/ml. Since the cell volume is ~ 150 ml the total tritium inventory in the cell corresponds to 48 × 150 = 7.2 μCi. After correcting for the tritium initially present in the D_2O both in the initial charge as well as make up volumes, it is estimated that an excess of approximately 7 μCi of tritium was produced due to cold fusion reactions.

Considering that the total number of neutrons generated was ~ 2×10^{7}, this leads to a neutron to tritium yield ratio of approximately ~10^{-7}.

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TABLE I. Salient Features of the Ti-SS Cell

Volume of Ti Cathode	57 cm^3
Area of Cathode	104 cm^2
Current	40 A — 60 A
Current Density	< 600 mA/cm^2
Electrolyte	20% (5 Molar) NaOD in D_2O
Volume Of Electrolyte	150 cm^3

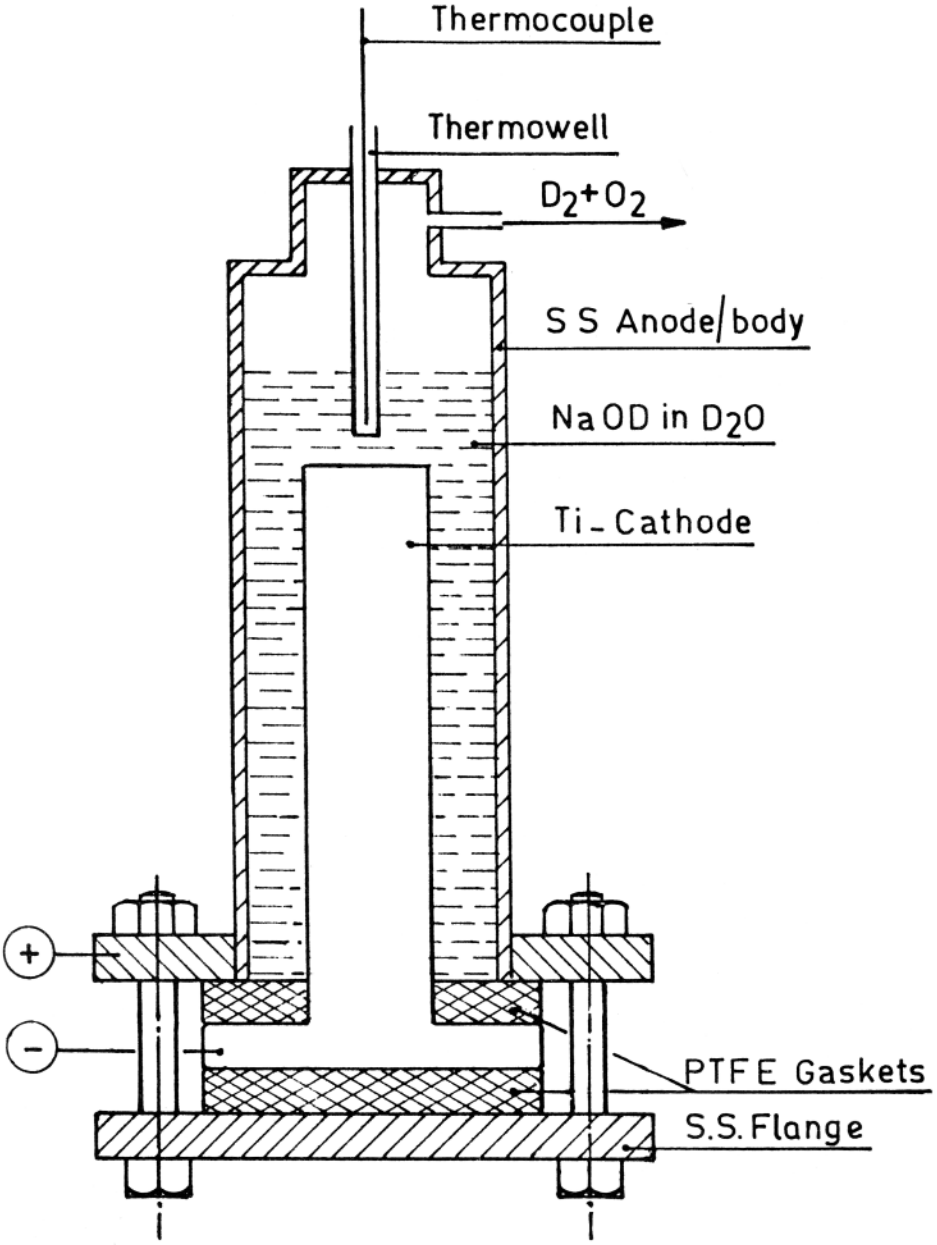

Fig.1. Ti-SS Electrolytic cell

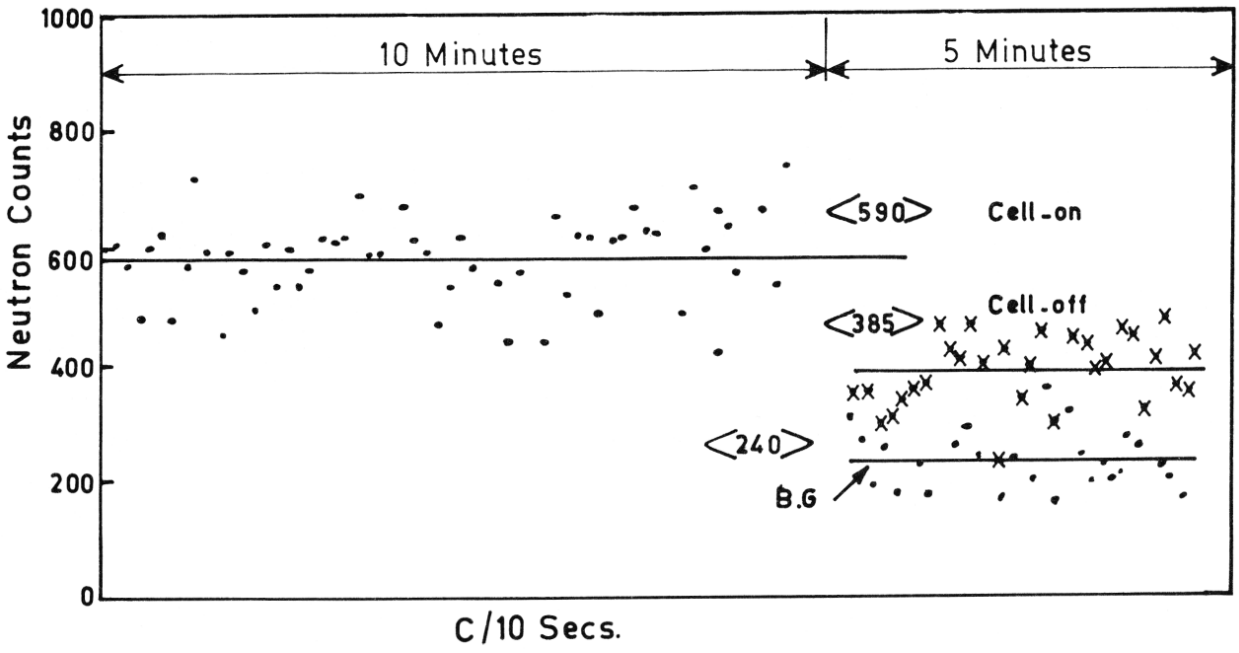

Fig. 2. Titanium - Fe Cell: Neutron Counts Variation With Cell On And Off