ENERGETIC CHARGED PARTICLES FROM DEUTERIUM METAL SYSTEMS

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We report on measurements made a number of years ago of energetic charged particles which were emitted from deuterium metal systems subject to non-equilibrium conditions of temperatures and electric currents. These measurements include (i) thin Titanium foils deuterated at moderately high temperatures in a deuterium atmosphere and then monitored as they were cycled from LN2 to room temperatures; (ii) charged particle detection of Ti foils exposed to a deuterium glow discharge; and (iii) observation of charged particles from Ti foils following bombardment with energetic deuterium ions.

1. Introduction

Following the initial reports in 1989 of excess heat and nuclear phenomena from deuterium metal systems at room temperatures, we undertook a series of experiments devoted to the detection of energetic charged particles from thin deuterated metallic foils subject to a variety of non-equilibrium physical conditions. The motivation for this approach was the possibility that the excess heat in the presence of a very low associated neutron background was due to energetic charged particles from deuteron induced nuclear reactions. We carried out three independent experimental approaches to this search. In every case very clear unambiguous observations of charged particles, with energies up about 6 MeV were made.

2. Deuterium loaded foils

The first measurements consisted of preparing deuterated Ti foils by heating in a deuterium atmosphere. The foils were then placed in vacuum and cooled to LN2 temperatures and allowed to slowly warm up while an electric current was passed through the foils. Intense bursts of charged particles with energies up to about 4 MeV were seen during these warm up periods. Details of the target preparation and these results have been published elsewhere[1,2].

3. Glow discharges

We fabricated a small glow discharge chamber with charged particle detectors viewing the Ti cathode during deuterium glow discharge. Details of the design and operating parameters are given elsewhere[1]. In Figure 1 (top) we show the spectrum

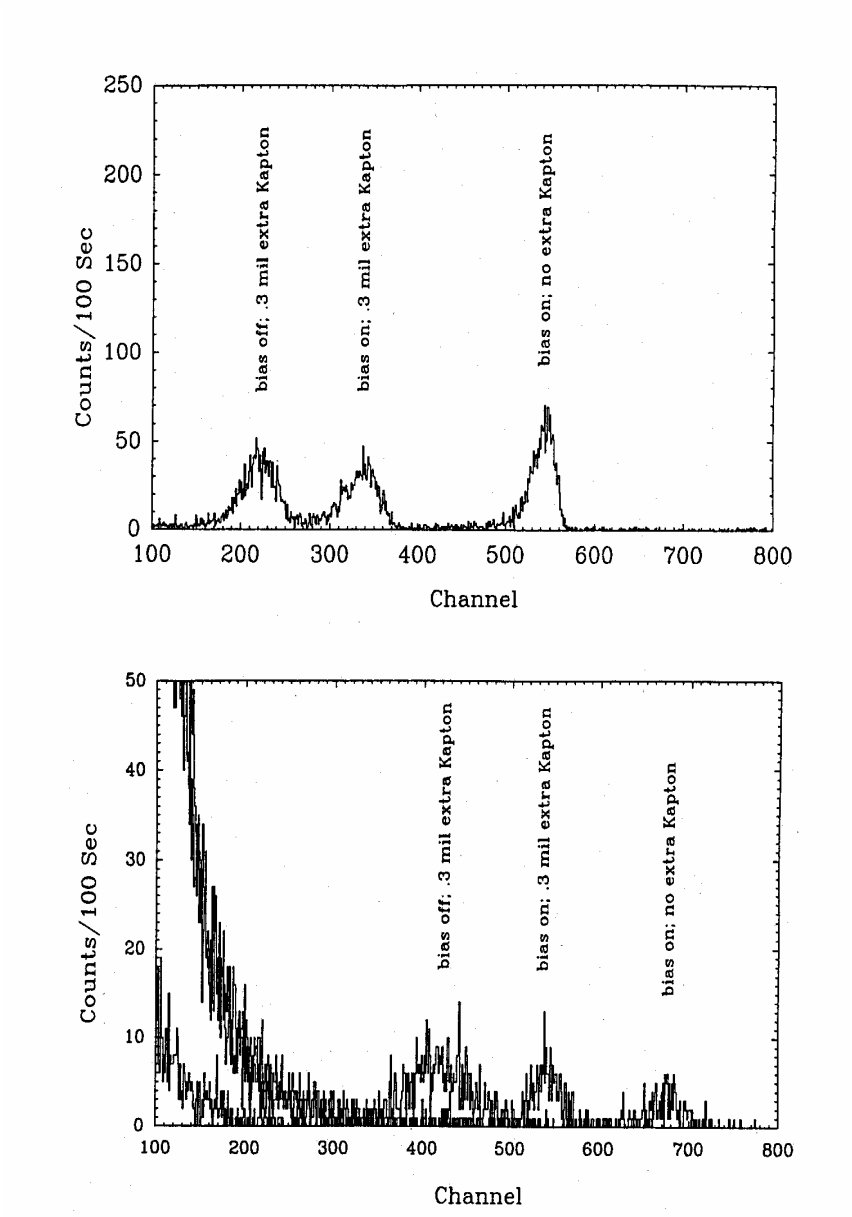

Figure 1. Top. Spectrum of 214Am calibration source with and without detector biases and Kapton degrading foil. Bottom Spectrum of deuterium glow discharge with Ti cathode with and without detector biases and Kapton degrading foil. The energy of the alpha particles from the 241Am source in the upper spectrum is 5.48 MeV. The energy of the group in the lower spectrum centered at channel 670 is approximately 6.8 MeV

measured with a 0.1 μCurie ^{241}Am calibration source, with and without the applied detector bias and with and without an extra Kapton degrading foil in. The spectrum measured during one of the glow discharges under the same set of detector conditions is shown in the bottom of Figure 1. The similarity between these spectra is striking and the fact that the energy calibration of the two spectra is identical indicates the production 6.8 MeV particles with an average source strength of roughly several thousand particles per second.

4. Ion bombardment

A deuterated Ti titanium target was prepared by bombarding a Ti foil with 30 keV deuterium ions for several hours at a current of 10 μAmperes from the Colorado School of Mines particle accelerator[3]. The spectrum measured during the bombardment is shown in the top of Figure 2. The three particle groups are from the d-d reactions between the beam ions and the previously implanted deuterons. The spectrum measured following the bombardment (with the gate valve to the accelerator closed) and with the temperature of the target at about 190 K is shown in the bottom of Figure 2. The somewhat broadened peak at channel 100 in the lower spectrum suggests, by comparison with the top figure, the production of 3 MeV protons.

5. Conclusions

We have obtained solid evidence, under three independent sets of experimental circumstances, for the anomalous production of energetic charged particles from deuterium metal systems. Further work to reproduce these results and to enhance their repeatability is encouraged. This work was supported by the U.S. Department of Energy and the Electric Power Research Institute.

References

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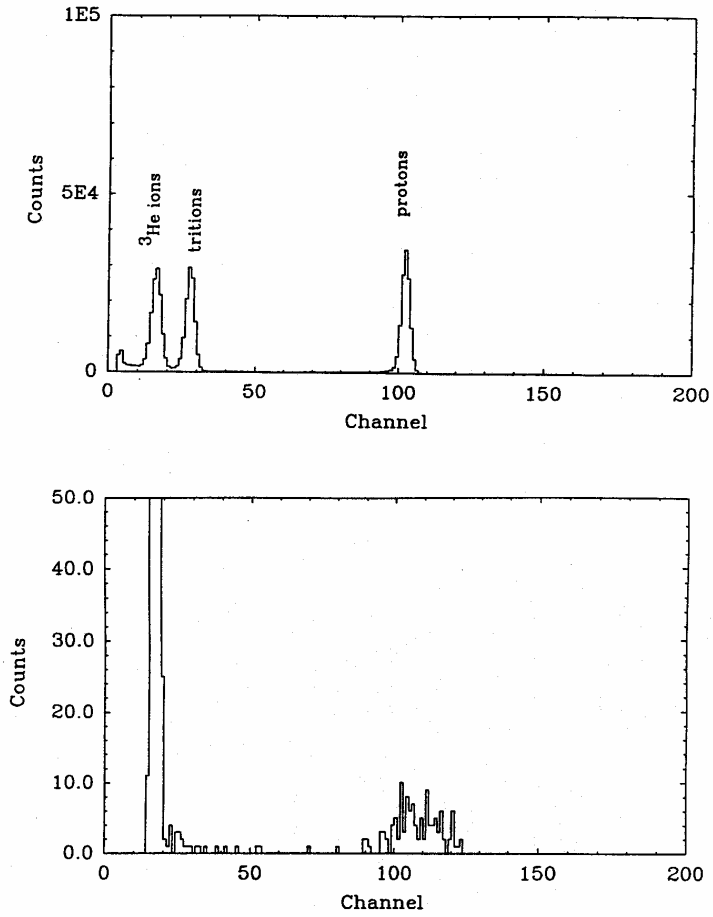

Figure 2. Top. Spectrum measured during bombardment of Ti target with deuterium ion beam. Bottom spectrum measured following deuterium ion bombardment with target at 190 K.