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The Measurement of Neutron Emission from Ti Plus D_2 Gas

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We have measured neutron emissions from cylinders of pressurized D_2 gas mixed with various forms of Ti metal chips and sponge. For some of the cases, the Ti was coated with a surface layer of Pd. The gas pressure ranged from 7–50 atm, and the Ti loadings ranged from 10–200g.

The neutrons were measured using high efficiency (21–34%) cavity-type detectors containing 6–18 ^{3}He tubes. Random neutron emissions were observed as well as time-correlated neutron bursts. The time spread in an individual burst was less than 100 μs.

The neutron emission for some of the samples was observed after the cylinder had cooled to liquid nitrogen temperature and was warming to room temperature. The bursts occurred about 40 minutes into the warm-up phase, and the random emission occurred for at least 19 hours after the sample reached room temperature. This cycle could only be repeated a few times before neutron emission ceased.

The neutron emission rates were very low and the 19-hour random emission rate was 0.05–0.2 n/s. However, this yield was still 10.4σ above the background. The instantaneous neutron bursts were more dramatic with yields several orders of magnitude above the coincidence background rates.

We are using four separate neutron detector systems operated in parallel experiments. The detectors all utilize ^{3}He gas proportional counters embedded in a polyethylene (CH_2) moderator. The electronics are based on shift-register circuits that give both the random and time-correlated neutron counting rate. The time-correlated neutron counting is essential for the neutron burst results that we have observe. Every neutron count that enters the circuitry triggers the time-correlation counters that check if there are any other neutron counts within the selected time gate. We are using a coincidence time gate of 128 μs.

A recent example of the neutron burst results for a D_2 gas phase experiment is shown in Fig. 1 where the number of time-correlated counts in 2000 s counting bins is plotted as a function of time after loading the D_2 gas. This sample (Ti-16) contained 108 g of Ti sponge, sintered Ti + Pd powder, Pd, V, and Zr foils all of which had been through several days of electrolysis in D_2O cells. We also have had burst results from D_2 gas cells filled with only Ti alloy (6% Al, 6% V, and 2% Sn).

In addition to the gas phase experiments, we have run four experiments using electrolysis cells. Each of the experiments had six D_2O cells. The anodes were gold

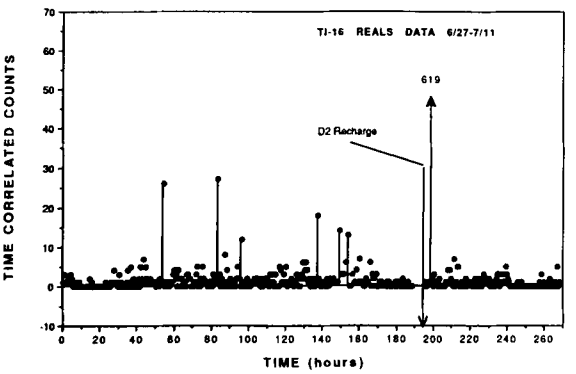

Fig. 1. Neutron burst results for D_2 Gas cylinder T-16 where the number of time correlated counts in a 2000 s time bin are plotted as a function of time after loading the D_2 gas. At about 195 h into the experiment, the D_2 gas was refilled from 1–40 atm.

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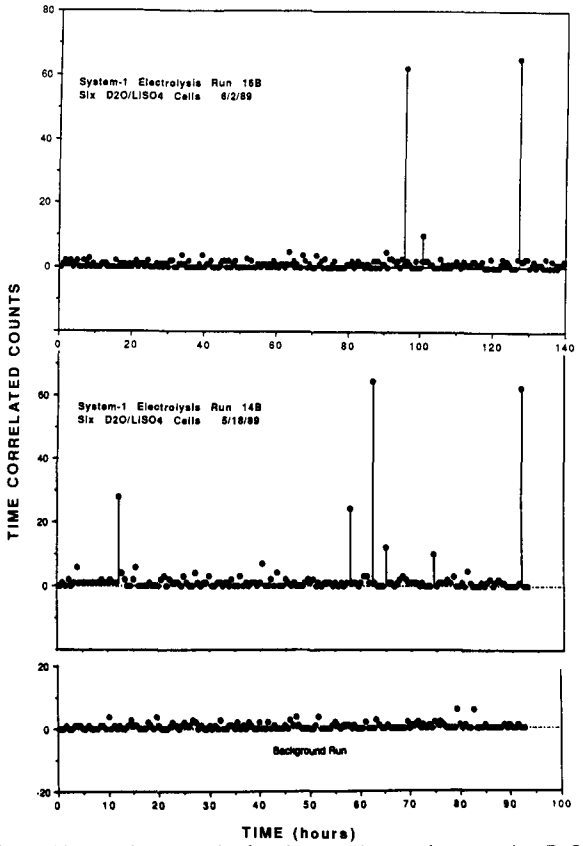

Fig. 2. Neutron burst results for electrolysis experiments using D_2O/Li_2SO_4 solution. The number of coincidence counts in a 2000 s time bin are plotted as a function of time after starting the electrolysis current.

foils and the cathodes varied with Ti, Pd, and V metal, foils, crystals, and sponge.

Two of the electrolysis experiments have yielded neutron burst results (see Fig. 2). The background runs contained six D_2O cells without electrodes.

We have measured both burst and random neutron emissions from nine different experiments; however, we have not been able to identify the neutron production mechanism at this stage of our work. Work is continuing to identify the neutron energy and neutron source characteristics.