PRELIMINARY EXPERIMENTAL STUDY ON COLD FUSION USING DEUTERIUM GAS AND DEUTERIUM PLASMA IN THE PRESENCE OF PALLADIUM

ALBERT G. GU, ROBERT K. F. TENG, MARK S. MILLER, and WAYNE J. SPROUSE Mississippi State University
Mississippi State, Mississippi 39762-6343

Received May 19, 1989
Accepted for Publication May 19, 1989

A series of experiments using deuterium gas and deuterium plasma in the presence of palladium has been designed to observe the possibility of cold fusion.

Two kinds of preliminary experiments were recently performed. One involved the diffusion of deuterium gas into palladium. The gas was cooled by liquid nitrogen, and then the temperature was permitted to rise to room temperature, going from near −54°C (−30 to 67°F) in 75 min. A spherical lithium neutron detector, 21 cm from the palladium, gave an audible indication of neutron levels approximately equal to, but above, background. A second experiment used a deuterium ion beam (1 keV) that bombarded a palladium target. An average counting rate of 36 ± 6 counts for 2 min was measured by a BF₃ tube with a paraffin moderator, 50 cm from the target. The background varied from 1 to 7 counts for each 2-min counting period and averaged 4 ± 2 counts in 2 min. A nitrogen ion beam impinged on the same palladium target producing 6 counts for a 2-min counting period. The palladium specimens were a piece of foil and a tube that was used as a palladium leak in a neutron generator. These preliminary experiments will be repeated, improved, and extended later.

THE EXPERIMENTS

Figure 1 is the experimental arrangement for the deuterium gas experiment. A large glass tube with 12-cm outer diameter, 62-cm length, and 1-cm wall thickness was used as a vacuum chamber and to contain the deuterium gas. A copper coil permitted liquid nitrogen to be introduced to cool the gas in order to observe the presence of neutrons as the assembly rose to room ambient temperature. A 5.5-cm-long × 3-mm-diam palladium tube and a palladium foil with surface area of 10 cm² were attached to a steel disk inside the chamber. Two Chromel/Alumel thermocouples were installed to estimate the palladium and gas temperatures. A Ludlum model 14C spherical neutron detector was located 21 cm from the palladium to estimate the neutron production rate as the assembly warmed to room temperature, a range from near −34°C (−30 to 67°F). The glass tube was evacuated to 48 Torr and then pressurized to 10 psig with deuterium gas. The audible response of the measuring instrument was observed during the 75-min warming period. Although the audible response including background was recorded and appeared to be approximately twice the background while the deuterium gas was resident in the chamber, the experimental results are believed to be inconclusive.

For the deuterium plasma experiment, the ion beam was created using the experimental arrangement shown in Fig. 2. The system has a vacuum chamber, plasma chamber, microwave heating system, vacuum system, and the necessary auxiliary equipment. A BF₃ neutron detector located 50 cm from the target and enclosed in a 55-cm-long × 7.5-cm-thick paraffin moderator was used to observe the neutrons.
palladium samples were as described previously. The palladium was attached to a target disk, cooled by water, and located at the center of the vacuum chamber. The target disk was electrically grounded, and the counting electronics were shielded from the plasma system by metal plates.

The experimental volume was evacuated to a pressure of $3 \times 10^{-5}$ Torr. Background measurements were made ten times and revealed an average value of $4 \pm 2$ counts for 2-min counting periods. A nitrogen ion beam was created first and used to bombard the palladium. The counting equipment recorded 6 counts during each 2-min counting period. Deuterium gas was then substituted for the nitrogen, and the 1-keV ion beam bombarded the palladium. The average counting rate was observed to be $36 \pm 6$ counts for repetitive 2-min counting periods.

**PHENOMENA AND DISCUSSION**

From these preliminary experimental results, no conclusions can be made. However, we did observe several interesting phenomena. Even though a high-sensitivity neutron detector was not available for these experiments, differences between the background and the experimental results were
observed and the latter was higher than the former. Is it some kind of noise or fluctuation? The stable background seemed to indicate that it is not noise. Also, the neutron detectors were tested with a standard neutron source, and they worked well. We did find what we believe to be electrostatic interference of the ion beam system with the BF$_3$ tube counting circuitry, but this was solved by interposing two large iron plates. During the experiment with the shield in place, the background was stable with or without the microwave and magnetic fields operating that implied electrostatic interference.

The second interesting phenomenon is that the nitrogen ion beam bombarding the palladium produced counts equal to the background, but the deuteron beam produced eight times higher counts than the background. Is this phenomenon the same kind of reaction as occurs when a high-energy deuteron beam bombards a deuterium target, as might occur because the deuteron was absorbed in the palladium? Because the energy of the ions in our experiment was ~1 keV and the deuterium-deuterium fusion cross section at 1 keV for monoenergetic beams is only 0.1430 x 10^-41 cm$^2$ (Ref. 4), the reaction may be "cold fusion" rather than "beam plasma" fusion, if any fusion reaction occurs.

The third interesting phenomenon occurred during the deuteron beam experiment. The counts gradually decreased to background in several minutes after turning off the microwave and purging with nitrogen. Does this mean that the remaining deuterons in the palladium still reacted with each other even though the deuteron beam no longer existed?

At the time of this writing, a high-sensitivity neutron detector, the mass spectrometer, and new palladium are not available for further study. These preliminary experiments will be replicated, improved, and extended later. For example, the hydrogen will be used as a gas and as an ion beam.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to M. A. Prelas, University of Missouri-Columbia, for his advice, and to C. A. Sparrow and J. P. Minyard for their help. We acknowledge the support from the Department of Mechanical and Nuclear Engineering, the Department of Electrical Engineering, the Engineering College, and the Graduate School of Mississippi State University.

REFERENCES

2. "Accelerator 1 Neutron Generator," PICKERNUCLEAR.