A PROPOSAL FOR A COLD FUSION STUDY IN THE Ti/D SYSTEM

COLD FUSION

TECHNICAL NOTE

KEYWORDS: *cold fusion, titanium electrode, low temperature*

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Received June 24, 1991
Accepted for Publication August 26, 1991

To enhance the cold fusion process in the Ti/D system, a special experimental procedure is proposed that includes electrolysis in nonaqueous solutions at low temperature (about −70°C), surface pretreatment by depositing nickel film on titanium electrodes, and a unique triggering method based on passing current axially through the electrode wire.

Since the first claims of nuclear fusion in deuterized metals at room temperature[1,2] were made, positive results have been reported at two international conferences on cold fusion[3,4] and in scientific journals, concerning neutron,[5-11] tritium,[12,13] and charged-particle[14,15] production as well as excess heat generation.[16-19] It has been shown that cold fusion may result from some nonequilibrium processes in highly deuterized metals; e.g., a rapid change in the configuration of host metal atoms could create unique "cold fusion active sites."

Accordingly, it is necessary to complete the following three procedures to obtain positive results:

1. loading deuterium into metals to a saturated (or oversaturated) level
2. triggering the deuterized system to a nonequilibrium state
3. capturing the reaction products with highly sensitive and reliable detection systems.

Procedure 2 has been underestimated by many groups. In fact, a nonequilibrium state has been triggered unintentionally in some cases because highly deuterized metal, as a pseudo-steady-state system, is easily triggered by either internal or external effects. For example, during a long electrolysis with a constant current, both macro and microstructures in the metal could be changed abruptly by distortion of the metal lattice, phase transition, or microcracking. Therefore, a carefully designed and efficient trigger process may create more cold fusion active sites simultaneously rather than randomly, which could be critically important for the success of procedure 3.

Menlove et al.[5] and Jones et al.[6] reported some interesting results with relatively high reproducibility regarding observations of neutron bursts from deuterized titanium chips in gas systems during thermal cycles, especially when the temperature is increased from that of liquid nitrogen to about −30°C. Similar results have also been obtained by other groups.[4] The phase transition of titanium at about −30°C may play an important role, and an internal force may be formed during this transition process that produces cold fusion active sites under nonequilibrium conditions. Advanced detection systems have been employed by these groups so as to capture the products more efficiently and to discriminate the signal from noise accurately.

The loading procedure and surface pretreatment of the titanium samples, however, have not been given much attention. Titanium samples with very large surface areas, e.g., titanium turnings, have been used, and the loading level was found to be much lower than that in palladium systems, which seems to imply that the preconditioning is unnecessary for high loading levels. However, some researchers have noticed that only a very low percentage of the titanium chips (<1%) have proven to be active and to produce nuclear products.[4] Titanium prefers to be deuterized with a nonuniform distribution: a high concentration of deuterium in the near-surface region rather than through the entire bulk phase.[20,21] Therefore, it is quite possible that those active titanium chips may consist of a much higher concentration of deuterium, at least in the near-surface region.

To gain more intense and reproducible signals from the nuclear reaction in the Ti/D experiment, which seems to be one of the most promising systems for the cold fusion effect, some improvements could be considered: (a) gaining a higher D/Ti loading ratio by using a special electrolysis method and (b) triggering the system more efficiently by designing a high-current passing method as a substitute for the thermal cycle.

To study the effect of the phase transition taking place at about −30°C in electrochemical systems, the electrolysis can be carried out in nonaqueous solutions such as in a D_2O/methanol solution, e.g., 95% CH_3OD + 5% D_2O + 0.1 *M* $LiClO_4$ (or 0.1 *M* DCl), at low temperatures. Some groups have studied the electrochemical behavior of titanium and its

alloys in a methanol/water system at room temperature.[22-24] It would not be too difficult to study the Ti/D system at a temperature around −70°C because the freezing point of methanol is −98°C. Moreover, the loading level of deuterium into titanium can also be enhanced under this condition since the loading level increases with decreasing temperature of the system.

The surface pretreatment is very important for the loading process to be successful. The hydrogen diffusion rate in hydrides of titanium increases by one order of magnitude after the careful pretreatment of the titanium sample.[25] Surface pretreatment such as deposition of a thin nickel film onto the titanium sample can increase the hydrogen absorption rate significantly.[26,27] Moreover, the deposition of a foreign metal onto titanium can also prevent the formation of a surface oxide layer on the titanium. On the other hand, titanium is a very active metal and easily forms an oxide film[21]; this process is easier to control in electrochemical systems than in gas systems. Therefore, it is possible to design some dedicated electrochemical experiments to form different types of oxide layers as a special surface pretreatment for titanium so as to understand whether the oxide film favors or inhibits the cold fusion process.

After the loading process at low temperature is completed, there are several ways to trigger the electrochemical system to a nonequilibrium condition by changing the applied potential or temperature. To examine the role of the titanium phase transition in the production of neutron emission at about −30°C, a unique test of the thermal effect on Ti(D) samples is proposed here. An electrode of titanium wire with a diameter of ~2 mm (a strip of titanium sheet can be used to increase surface area) is bent into a U shape and then coated with a thin nickel deposit. The two ends of the U-shaped electrode are connected to two lead wires that have high melting points.

After the loading process is completed, the electrode can be heated by applying a direct current (or an alternating current) axially through the wire electrode in series with a variable resistance that is connected to a power supply. Thereby, the temperature of the sample can be increased very quickly or slowly, depending on the current density, which is controlled by the variable resistance. This triggering procedure may enhance the activities of Ti(D) samples in the emission of neutrons since it can increase the sample temperature very rapidly and possibly prompt the phase transition. In comparison with the thermal cycle in the gas system, this triggering procedure is not only easier to control but also more efficient because the former gradually heats samples from surface to center while the latter can heat the entire sample evenly in a short time. Therefore, such a thermal test could be helpful in revealing the related mechanism.

To increase the possibility of detecting nuclear products, a set of these electrodes can be placed in one electrochemical cell and loaded with deuterium at the same time; then the electrodes can be heated either in sequence by passing the current through one at a time or by simultaneously applying the heating current, or just by simply changing the circulating bath temperature. Moreover, a special electrochemical cell can be made so that after the loading process by electrolysis, the electrolyte can be drained down just before the start of the heating (triggering) process; therefore, the energy spectrum of the emitted neutrons can be obtained without interference from the liquid. Finally, the experimental procedure presented here can also be applied to other deuterized metals such as the Pd/D system.

ACKNOWLEDGMENTS

I wish to acknowledge interesting discussions with M. Fleischmann, S. Pons, and F. G. Will. A useful suggestion from M. Hawkins is gratefully acknowledged.

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