Parmenter, R.H., *Enhancement of Cold Fusion Processes in Palladium by Catalytic Agents.* Infinite Energy, 2002. **8**(43): p. 66.

Enhancement of Cold Fusion Processes in Palladium by Catalytic Agents

R. H. Parmenter *

The process of fusion of a pair of deuterons into an α particle in palladium metal can be enhanced by the presence of free protons. The process of fusion of lithium 6 and a deuteron into a pair of α particles can be enhanced by the presence of free neutrons. In both cases the enhancement is appreciable. Consider the following reactions in palladium metal:

$$\begin{aligned} &{}^{1}H^{1} + {}^{1}H^{2} \rightarrow {}^{2}He^{3} + 5.40 MeV \\ &{}^{2}He^{3} + {}^{1}H^{2} \rightarrow {}^{2}He^{4} + 18.26 MeV. \end{aligned} \tag{1}$$

A deuteron and a proton in a tetrahedral cavity in the metal fuse to form helium 3 and 5.40 MeV. The energetic helium 3 crashes into another deuteron in a neighboring cavity, forming an α particle, a proton, and 18.26 MeV. The net result is identical to the direct fusion of a pair of deuterons into an α particle.

$$2\,{}^{`}H^{2} \rightarrow \alpha + 23.66 MeV. \tag{2}$$

In (1) the proton serves as a catalytic agent and is not consumed. In the first reaction of (1) and in that of (2), the factor limiting the process is the Coulomb repulsion partially screened by the conduction electrons of the metal. In the second reaction of (1), the energetic helium 3 easily overcomes the Coulomb barrier. The rate X at which a reaction can occur is proportional to the Gamow penetration factor exp[-2πη], which is the probability of quantum mechanical tunneling through the Coulomb barrier. Some years ago, Parmenter and Lamb[1] calculated the rate at which a pair of deuterons in a tetrahedral cavity in palladium would fuse to form either a proton and hydrogen 3 or a neutron and helium 3. In their last paper they found

$$\begin{aligned} &\lambda = 9.1757 \times 10^{-24} \sec^{-1} \\ &2\pi\eta = 81.0184. \end{aligned} \tag{3}$$

This same value of 2πη is appropriate for the reaction of (2). For the first reaction of (1) however, 2πη will be smaller. This is because η is proportional to the square root of the reduced mass of the reacting particles. Thus the η of the first reaction of (1) will be smaller than that of (2) by a factor of $(2/3)^{1/2}$. The Gamow penetration factor for the first reaction of (1) will be *greater* than that of (2) by the factor

$$\exp\left\{-81.0814\left[(2/3)^{1/2} - 1\right]\right\} = 2.90 \times 10^{6}. \tag{4}$$

This suggests that the rate of fusion of a pair of deuterons into an α particle will be strongly enhanced by the presence of free protons. The energetic α particles of reaction (1) can generate

* Department of Physics, University of Arizona, Tucson, AZ 85721

energetic deuterons in the metal by elastic collisions, which in turn can lead to enhancement of the processes considered by Parmenter and Lamb.[1]

This work was inspired by the remarkable results of Mizuno *et al.*[2] These workers used two electrolytic cells, the first one with a reagent containing heavy water, the second one with a reagent containing light water. A palladium cathode was placed in the first cell and electrolysis was performed for three hours, thereby loading the cathode with deuterons. Following this, the cathode was inserted into the second cell and electrolysis was started. After a sharp increase of the voltage on the cell was initiated, a large burst of neutrons was observed. A possible explanation is that the voltage jump caused a large concentration of protons immediately below the surface of the cathode amongst the deuterons, thereby initiating the catalytic process described earlier. The fact that the burst of neutrons did not last may be due to the large concentration of protons near the surface decreasing because of diffusion into the bulk of the cathode. One type of reagent used in electrolytic cells may be formed by inserting lithium metal into heavy water, generating LiOD. This allows both deuterons and lithium 6 to be present in the cell. Consider the following reactions:

$$\begin{aligned} &{}^{3}Li^{6} + n \rightarrow {}^{1}H^{3} + {}^{2}He^{4} + 4.78MeV, \\ &{}^{1}H^{2} + {}^{1}H^{3} \rightarrow n + {}^{2}He^{4} + 17.50MeV. \end{aligned} \tag{5}$$

A lithium 6 nucleus and a neutron react to form a triton (hydrogen 3), an α particle, and 4.78 MeV. The energetic triton crashes into a deuteron, forming a neutron, another α particle, and 17.50 MeV. The net result is identical to the direct interaction of a deuteron and a lithium 6 nucleus to produce two α particles.

$${}^{3}Li^{6} + {}^{1}H^{2} \rightarrow 2\,{}^{2}He^{4} + 22.26MeV. \tag{6}$$

In (5) the neutron serves as a catalytic agent and is not consumed. In the first reaction of (5), there is no Coulomb repulsion to inhibit the neutron from interacting with the lithium 6 nucleus. In the second reaction of (5), the energetic triton easily overcomes the Coulomb barrier. In the reaction of (6) however, the factor limiting the process is the Coulomb repulsion partially screened by the conduction electrons of the metal. This suggests that the rate of interaction between a deuteron and a lithium 6 nucleus to form a pair of α particles will be strongly enhanced by the presence of free neutrons.

In an experiment studying this catalytic reaction, the electrolytic cell should contain sufficient volume of reagent in order that free neutrons can thermalize inside the cell. An external source of neutrons may be necessary in order to maintain the density of thermal neutrons inside the cell sufficiently high for the catalytic process to proceed. For the same reason, the cell should be surrounded by a shield reflective for neutrons.

In conclusion, cold fusion processes in palladium can be enhanced by catalytic agents.

References

1. Parmenter, R.H. and Lamb, W.E., Jr. 1989. *Proc. Natl. Acad Sci. USA,* 86, 8614; Parmenter, R.H. and Lamb, W.E., Jr. 1990. *Proc. Natl. Acad. Sci. USA,* 87, 3177, 8652.
2. Mizuno, T, Akimoto, T, Ohmori, T, Takahashi, A., Yamada, H., and Numata, H. 2001. *Jpn. J. Appl. Phys.,* 40, L989.