Proposal of an Experiment Aimed at Charging Deuterium in Palladium at the Temperature of Liquid Nitrogen

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Abstract. One of the most established features of the phenomenon known with the name of "Cold Fusion", with reference to the system palladium (Pd) – deuterium (D), is that a condition necessary (even though not sufficient) to be satisfied in order for these phenomena to take place is that the content of D in Pd, called also the D/Pd ratio X, approaches the value of 1 (understanding by this quantity the atomic ratio between the two species in the Pd lattice).

In order to reach such an high value of X, extensive use of electrolysis of heavy water with a Pd cathode has been made. An alternative line that has been followed by the Author [1] consists of trying to obtain high values of X by the direct interaction of Pd with D_2 gas. The use of low temperatures has the purpose of increasing the equilibrium loading ratio for a given gas pressure.

The proposal of an experiment which requires little attention is presented here.

1. Introduction

When facing the task of loading deuterium (or hydrogen) in palladium, with the aim of reaching high values of the loading ratio X = D/Pd, the following parameters have to be considered:

- temperature: X increases as temperature decreases;
- pressure: X increases as pressure increases;
- minimum linear size of the sample: diffusion regulates the distribution of D within the lattice of Pd, and the coefficient of diffusion decreases as temperature decreases; conversely using low linear size samples shortens the diffusion times;
- as a consequence of the latter, time becomes an important parameter when planning an experiment.

To give an idea, in the quoted experiment [1] a value of X = 1 was obtained with a pressure slightly lower than 1 bar, at the temperature of 150 K, with a sample 3.6 μm thick. The time necessary in order to reach thermodynamic equilibrium starting from the moment in which D_2 went in contact with Pd, was in the order of one week.

The idea at the base of this proposal is to have a much simpler experiment, able to run for a long time substantially unattended, in order to handle long lasting runs. It consists of using a sample of larger mass and lower dimensionality than the one used in [1], held at the temperature of liquid nitrogen (LN2), while in touch with D_2 gas at a rather high pressure, and realizing a very simple calorimeter, so that the possible excess heat be the only parameter to be measured and recorded. In this way, it would be possible to perform very long runs, lasting weeks, or even months.

It has been said that another necessary condition to satisfy in order to have cold fusion phenomena, is to have a motion of the D ions in the lattice of Pd: in the system presented here diffusion should be able to provide this kind of dynamic regime.

The calorimeter will be described here.

2. The calorimeter

The calorimeter is based on the use of an "old style" Supairco dewar, designed to contain either liquid helium or liquid hydrogen. It is well known that these liquids have a very low latent heat of evaporation; thus, in order to keep them in liquid form, their container has to be well protected from heat inlets of various types. In particular, in order to reduce the heat inlet by radiation coming from the outer envelope at room temperature, modern dewars have both MLI (MultiLayer Insulation) and metallic shields cooled by the evaporating He/H_2. However, till the years 'sixties these techniques were not yet applied: the way in which the radiation heat inlet was cut down consisted of having a liquid nitrogen dewar (77 K) surrounding the liquid helium (hydrogen) container, of course both in a good insulating vacuum. The reduction in heat power inlet due to radiation was thus cut by a factor $300^4/77^4 \approx 230$. In Fig. 1 a schematic drawing of such a dewar is shown.

For the calorimeter described here the idea is to put liquid nitrogen (LN2) also in the inner dewar, the one designed to contain liquid He/H_2. In this way the radiation heat coming from the surrounding container is cut to zero. The only heat inlet remaining is that by conduction through the stainless steel pipe sustaining the inner dewar, which is quite small, since a thin-walled pipe is used.

This remaining heat will produce a small constant evaporation of nitrogen from the inner dewar. Should any independent source of heat appear, there will be an increase in the evaporation rate, which will take place at a substantially constant temperature. The measurement of the increase of the evaporation rate will be easily transformed into heat inlet, since the latent heat of nitrogen is well known.

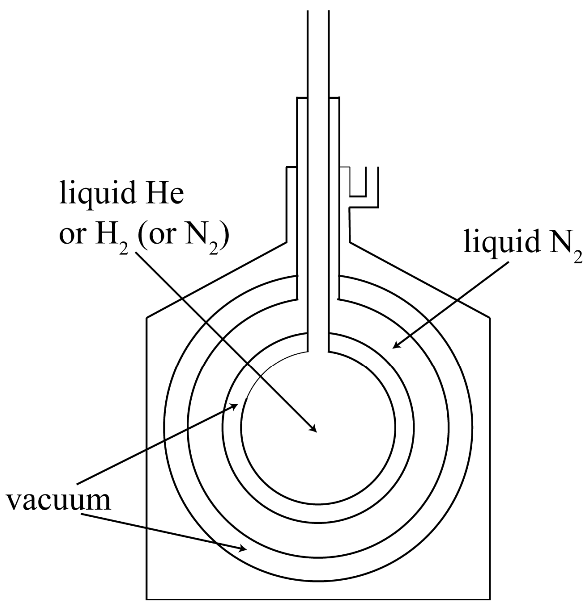

Fig. 1 - Schematic drawing of a Supairco "old style" liquid He/H_2 dewar.

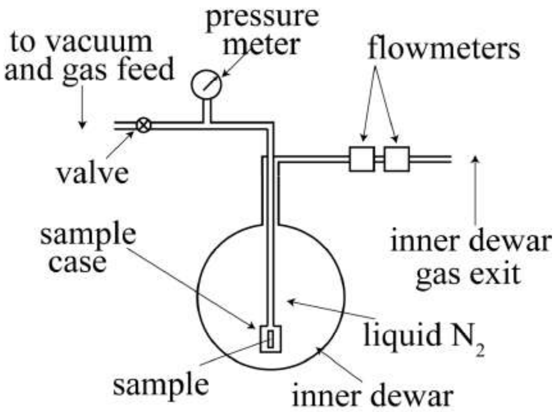

Fig. 2 - Scheme of the experimental set-up.

Thus, provided that the the nitrogen evaporation from the inner dewar is measured and recorded, the experiment can be run substantially unattended. The only operation to perform is, from time to time, to refill LN2 in the outer dewar.

3. The proposed experimental set-up

In Fig. 2 a scheme of the experimental set-up proposed is shown.

The sample is in a vacuum-tight case immersed in LN2 in the inner dewar. In the case high pressure (tens of bars) D_2 gas is put. Evaporation from the inner dewar is measured by a series of two flow meters of different full scale range and recorded with the help of a LabVIEW data acquisition system. Care is taken that the outer dewar be always at least half-full of LN2.

Excess heat in the sample will produce an increase in the evaporation rate of LN2, and will be detected by the flow meters. It will be easy to transform these data into heat or power.

4. A preliminary test

A test was performed, using gas meters, rather than flow meters. The outer dewar was filled with LN2, only 3 liters of LN2 were put in the inner dewar (this was a Supairco 10-liters dewar).

The (residual) heat input in the inner dewar, calculated from the evaporated gas, was constant in time, and amounted to 10 mW (it would take about 19 months to evaporate all the 3 liters of LN2).

The two flow meters in series that will be used will have 20 and 500 sccm (standard cubic centimeters per minute) range full scale. The first will give a reading of 2.47 sccm (the 10 mW quoted above) in the absence of heat excess. The second would give a reading of 240 sccm in the presence of a heat excess of 1 W.

5. References

[1] F. Scaramuzzi, *Journal of Alloys and Compounds*, 385, 19 (2004).