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Proposal for an Experiment designed to seek evidence for cold fusion

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Abstract

In experiments to investigate the application of gas phase as a medium for cold fusion, a Pd vessel was exposed to deuterium gas, dissociated in an electric discharge at between –10 and –20 degrees C. After absorption had proceeded for eight hours, neutrons were detected at levels approaching the full scale on the recording equipment. This lasted for three hours before falling to zero.

The gas remaining in the Pd was removed by exposing it to oxygen dissociated by the electric discharge. Water produced was collected in a cold trap and tested for beta radiation as evidence for tritium formation . The level of radiation found was over 6000counts/min This was 20 fold above the background since a similar sized sample of heavy water made from the deuterium gave a reading of 300c/min.

Further attempts to perform similar experiments were unsuccessful. At the time this was puzzling, however recent insights into solid phase gas fusion may shed light on possible causes for this failure and it is worth pursuing this approach as the gas phase presents certain advantages over methods currently used.

This work was carried out in 1990

Introduction

In experiments carried out in 1990 to investigate the application of the gas phase as a medium for cold fusion, a Pd vessel was exposed to deuterium gas, dissociated in an electric discharge at between –10 and-20 degrees C. The thickness of the metal was about one millimeter. In the first of a number of experiments positive indications of fusion were observed but these could not be repeated in subsequent experiments. The inability to repeat results has been found to occur in other cold fusion experiments and signifies that the processes involved are not understood (1). Since 1990, a number of results have been obtained which may put these earlier failures in a new light. In particular, the discovery by Miles(2), who reported positive results during electrolysis from 6mm thick rod after failure with Pd electrodes one mm thick. This introduces the bulk of the metal as a possible factor in the occurrence of cold fusion. Another noticeable feature of the absorption of deuterium in Pd is the obvious signs of cold work done on the metal. The surface is roughened, cracks appear and measurements show an apparent 15% increase in volume. With these factors in mind, a hypothesis has been formulated which seeks to explain how this might influence the process of cold fusion.

The absorption of hydrogen and its isotopes by Pd is associated with severe stressing of the metal. The work done on the crystal lattice causes dislocations in the metal that could be sites for the congregation of two or more protons. The ability of the metal lattice to contain these dislocations without rupture would depend to an extent on the support given by surrounding structure. It is conceivable that on this scale the probability amplitude for fusion could be significant. This hypothesis also introduces a factor that may decrease the strength of the metal to contain very small enclosures. If two dislocations are sufficiently close, the intervening bonding may break and combine the two enclosures into one. On a micro scale this could neutralize sites and on a macro scale cracks occurring could reduce the power of the host metal to perform. The physical size shape and condition of the metal is, in this scenario of a vital importance. Not only is there need for sufficient bulk to provide reinforcement to highly stressed parts of the lattice but the crystal size, shape, and the degree of cold work all have to be taken into consideration. Stresses produced in the metal by metallurgical processes like rolling, extrusion etc. cause concentrations of dislocations along slip planes and grain boundaries. These processes produce a preferred orientation of the microstructure, which can persist after annealing and recrystallization. On the other hand a result of significance in this context is the use, by Imam, (3), of up to 0 .75% of Boron as an alloying element. This gave an improved yield and supports the idea of a random distribution rather than anisotropic concentrations of dislocations. It is apparent that this hypothesis, if appropriate, places a significant reliance on the design of the host metal, particularly the size and shape.

Another factor in the absorption of deuterium by palladium is the surface characteristics of the metal. In experiments in a vacuum system using a gas discharge, it is common to use ion bombardment to remove gases, which adhere to the walls of the apparatus. Argon gas is introducing into the system and the discharge turned on. After a few minutes the system is evacuated. This procedure may enhance the surface of Pd for absorption.

What metallurgical properties should be sought for optimum performance of the host metal? It would seem desirable to have randomly orientated large grain sized metal with the least amount of previous cold working possible. e.g. castings slowly cooled from the liquid state in a preheated mould. The optimum shape for the maximum yield would appear to be a spherical sample and if this is cast, a rod of metal could be left attached to the sphere for holding it in position. This rod could also serve the function of heat conduit for temperature control and other sensor attachments. This part of the Pd sample could be neglected as far as protecting it from physical strain or surface damage. Soft solder could be used to facilitate thermal conduction and this would also provide a vacuum seal. Another feature of an experiment to find evidence for cold fusion would be the incorporation of a stylus with piezoelectric crystal attached to convert vibrations in the metal into a recordable signal. With the design suggested a stylus could be fitted externally to the vacuum to detect vibrations due to single fusion events. These considerations together with suggested improvements in the experimental technique used in the original experiment will be used as the basis for this proposal for an experiment to find evidence of cold fusion using the gas phase dissociation of deuterium.

Deuterium obtained from seawater contains negligible traces of tritium. Tritium free deuterium should be used for this experiment. Experimentally, there are advantages in using the electrolysis of tritium free heavy water as the source of the deuterium. This is because it is simple to make the deuterium gas in measured amounts during the experiment and to keep an account of the quantity used at any time. If there were equipment available, which can accurately meter the gas from a cylinder, then this would be simpler.

The gas discharge equipment may be either high voltage DC or high frequency induction apparatus such as a Hartley oscillator. In the former case the rectified output, controlled by a rheostat from a 10Kv voltage supply, is used in series with a 10K ohm ballast resistor. A stainless steel electrode connected to a feedthrough in the tube is connected to the anode and the cathode is connected to the Pd sample. With the induction apparatus, a coil around the reaction tube is used to establish the discharge. It is standard practice in gaseous dissociation work to decrease recombination by "poisoning" the walls of the reaction tube with phosphoric acid or other substances. In this experiment this would introduce hydrogen atoms unless the poison was "deuterated". Choosing the best generator depends on which type produces the most rapid absorption of deuterium. Until the two methods are compared by experiment, this cannot be predicted. This description uses the high voltage apparatus "without prejudice".

The palladium preferred for this experiment is the purest metal obtainable not necessarily because this is likely to produce the highest yield but because this metal does appear to posses the essential quality to enable cold fusion. The shape of the sample in this experiment gives the minimum surface area to volume possible. It is therefore likely that considerably longer period will be required to reach the concentration most suitable for fusion to occur than in earlier experiments. The size of the sample is a matter of guesswork because this shape may yield more fusion than previously seen. The cooling of the sample through a short length of thin rod would not cope with a rapid production of heat. It is therefore considered prudent to use a sample of modest size, say 18 mm diameter sphere with a 20 mm rod, 5 mm in diameter joined, as cast, for holding purposes. The cooling of this sample should be capable of rapid change as required to maintain a constant temperature. Safety shielding of the reaction tube should be used to protect operator. The use of two neutron detectors should be made for measurement of neutrons; one with the end closest to the sample and the other parallel to the tube holding the sample. If the detectors are calibrated against a standard neutron source in this same position, there should be no doubt about the level of emission recorded. The possibility of other types of radiation should not be ignored (4) and despite the "noise" generated by electrons from the discharge colliding with the glass walls of the reaction vessel, the recording of the emission of gamma rays, X rays and other electromagnetic radiation would be useful information.

Apparatus: A schematic sketch of the apparatus is shown in Fig.1.

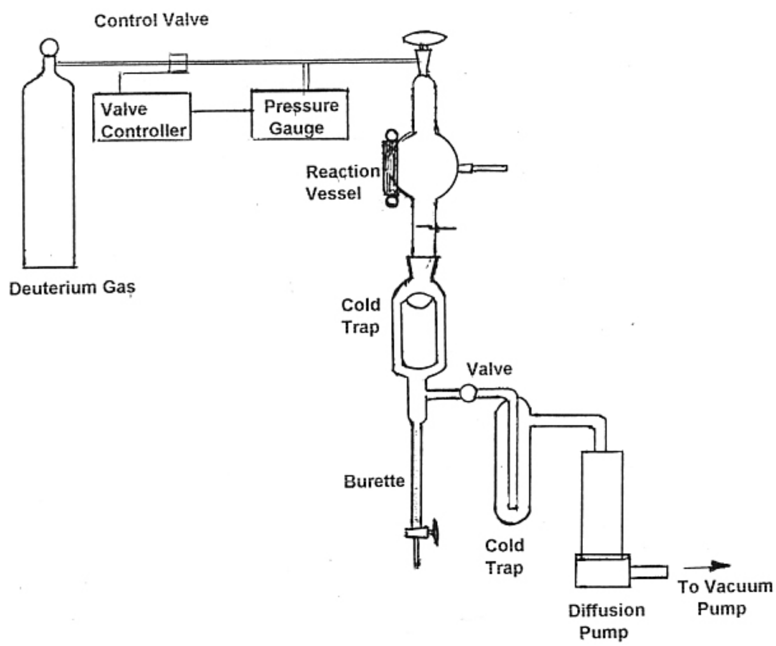

Fig. 1

Deuterium gas is supplied from a cylinder through a control valve, regulated by a pressure gauge, to a glass reaction vessel via a vacuum tap. The reaction vessel is connected to a cold trap and then to a burette for collecting heavy water from the cold trap above. A branch tube connects from the cold trap via a valve to another cold trap to prevent back diffusion from the oil diffusion pump. A length of rubber hose connects the diffusion pump to the vacuum pump to minimize vibration of the measuring equipment.

A sketch of the reaction tube is shown in Fig 2.

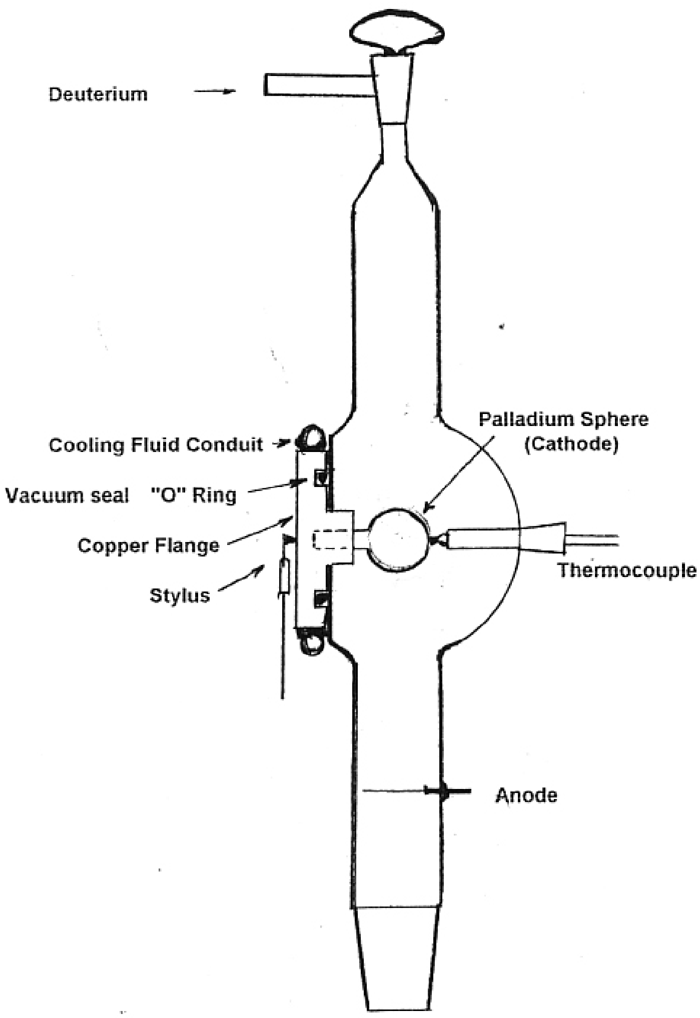

Fig. 2

A bulb at the center of the tube has a flat flange with a 2cm hole. A copper disk with a 1.8 cm boss fits onto this flange. The rod attached to the Pd sphere is soft soldered into a flat bottomed hole 0.5 cm deep in the copper boss. A tube for cooling fluid is soldered to the periphery of the disk, which has an “O” ring groove machined for sealing to the glass vessel. A feedthrough is located 3-4 cm from the center of the tube to attach a stainless steel anode. A socket is provided opposite the flange for a thermocouple. A stylus with piezoelectric crystal is attached to the center of the flange to detect vibrations produced in the metal. The flange is earthed and connected to the negative terminal of the power supply.

It would be desirable to record both vibration signals and neutrons on equipment, which could be analyzed afterwards, for coincidence of vibrations and neutron emission. An amplifier and speaker could be used to give an audible signal if events occur. The purpose of the cooling tube is to maintain a constant temperature in the Pd. Initially the flow of cooling liquid should be adjusted to maintain a constant temperature of –10 C when the discharge is on. If heat is produced by the fusion reaction the flow of coolant should be increased to maintain a constant temperature. This could be done by amplifying the voltage representing the difference in temperature between the copper flange and that at the opposite end of the Pd. This voltage may be used to regulate the circulating pump speed.

Experimental procedure.

When soldering the Pd sample, care should be taken to slowly heat the copper and the Pd in an oven to near the melting point of the solder. Care should also be taken to see no air is entrapped in the hole and that the metal is allowed to cool slowly after soldering is complete. Before mounting the sample in the reaction tube, the glass flange should be covered with a blank disk to test the flow system. The settings necessary to obtain a stable discharge and maintain it must be found before absorption of deuterium can commence. When the sample is mounted in the tube the vacuum system should be tested for several days or until all leaks have been fixed and out gassing stopped. Only silicone based oil or grease should be used in the system. When the soundness of the vacuum system has been established, the apparatus should be flushed with argon and the discharge run for a few hours and then evacuated. After cooling the sample to –10 C, the exhaust valve is closed, deuterium is admitted and the discharge turned on. It is not necessary to use a high current and so long as the discharge is stable. If for some reason the pressure becomes too high to sustain the discharge, the exhaust valve may be momentarily cracked open to reduce the pressure. This should be avoided if possible as it makes the measurement of gas used difficult. However the main aim of this experiment is to maintain a supply of deuterium atoms for as long as is necessary to produce evidence of fusion. Once success is achieved in this endeavor there will be ample opportunity to carry out enthalpy measurements etc. The cold trap directly connected to the reaction tube is charged with liquid nitrogen, the deuterium is disconnected and oxygen admitted into the reaction tube with the discharge turned on. The fluid cooling the copper flange may be replaced hot fluid up to 50 C. It may be necessary to briefly evacuate the reaction tube to lower the pressure so that a discharge can be maintained but if this is done too often tritium may be lost. It may take a day or more to remove all the deuterium and tritium from the Pd. When this is complete the discharge and the supply of oxygen is turned off. The reaction tube is filled to atmospheric pressure with argon. The cold trap is allowed to return to room temperature and the water collected from the burette. A measured quantity of the water collected is measured for beta radiation. This should be compared with the radiation from the same quantity of water produced from the deuterium from the gas cylinder. The Pd is removed from the reaction tube and melted in a vacuum furnace and the gas remaining is subjected to examination by mass spectrometer for Helium fusion products.

Conclusion. The purpose of this paper is to pass on the experience gained in this field and to promote the merit of the gas phase medium for this work. The increase in yields and the achievement of reproducibility will present great benefits for this branch of science.

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