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Internet Discussion Groups

Three groups deal with "cold fusion", often with a low signal-to-noise ratio: sci.skeptic, sci.physics and sci.physics.fusion

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Report Summary

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Development of Advanced Concepts for Nuclear Processes in Deuterated Metals

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Abstract

The excess heat generated in electrochemical cells with palladium cathodes and heavy water electrolyte appears to be far too large to result from chemical or metallurgical transformation. The evidence implies that the heat source is a nuclear reaction of some as yet undetermined nature.

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Background

Since first announced in 1989 by Fleischmann, Pons, and Hawkins, "cold fusion" has been the subject of widespread interest and intense controversy. Palladium (Pd) cathodes electrochemically charged with deuterium (D) to unusually high D/Pd ratios exhibit episodes of heat in excess of measured electrical inputs. Although nuclear reaction products commensurate with the excess heat have not yet been observed, small but definite evidence of nuclear reactions have been detected at levels some 40 orders of magnitude greater than predicted by conventional nuclear theory.

Objective

To measure, optimize, and control the excess heat produced in highly deuterated palladium cathodes; to measure any signatures of possible nuclear reactions associated with the production of excess heat.

Approach

The project team designed electrochemical cells that allowed precision calorimetry to be conducted while measuring all input heat from electrochemical and calibration resistor currents. The team operated 25 separate cell/calorimeters for periods of several days to several weeks each. Separately, the team operated 80 open cells to test various procedures for obtaining high cathode D/Pd ratios, a key condition for obtaining excess heat.

Results

Three conditions were found characteristic of all cells yielding episodes of excess heat: (1) a D/Pd ratio less than 0.9, (2) initial appearance times of 8 to 23 days, and (3) cathodic current densities above 0.1 A/cm2. Excess powers ranging between a few percent to approximately 350% were observed, measured to an accuracy of approximately 0.5%. These excess powers integrated to a total of approximately 0.1 to 1.1 MJ for an approximate 2.5 g (1/40 mole) palladium cathode. Thus, the excess heats ranged between 4 to 44 MJ/mole of palladium, which was well above the largest known heats of chemical transformation in this or any other metal. The largest heat of chemical transformation in palladium is to the bromide at 0.9 MJ/mole. If the integrated excess powers are diluted by the electrochemically generated heat during the long initiation periods, net positive heat balances of 2 to 4% are obtained.

EPRI Perspective

This work confirms the claims of Fleischmann, Pons, and Hawkins of the production of excess heat in deuterium-loaded palladium cathodes at levels too large for chemical transformation. However, the phenomena were obtained in only about half the cells. From the conditions of loading, initiation time, and current density on the successful observations of excess heat, it is understood why the phenomena are so difficult to attain. The conditions in the successful cells were not entirely under experimental control because the closed cells slowly leach silica and other materials from the anode and its supports as well as from the cell walls. This leached material can deposit on the cathode surface and interfere with the loading process. Also, the palladium purity depended on whatever was available from the manufacturer. Subsequent research has shown a pronounced batch effect on successful loading from different shipments of palladium from the same as well as from different suppliers. It is suspected that metallurgical conditions as well as impurity content may be the source of this batch effect.
The primary objective of further work on this subject will be to demonstrate which nuclear reactions, if any, are generating the excess heat. The only way to do this is to observe in at least roughly quantitative fashion the nuclear reaction products or "ashes." At this time, it is thought that the most likely ashes will be helium of mass 4 observable in the vapor phase of closed cells. The reaction producing helium needs to be known in order to maximize this excess heat phenomena for practical uses in the nuclear power industry.

Keywords

Electrochemical Power Generation
Palladium
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