

Implications of Isoperibolic Electrode Calorimetry for Cold Fusion : The Silica Effect

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ABSTRACT

Isoperibolic electrode calorimetry has demonstrated that four times as much heat is generated at the anode than at the cathode in D_2O . Experiments recognized that silica affected some results. Experiments in K_2CO_3 reported here identify silica as both a contributor to excess heat generation and as a factor in modifying the cell calibration constant. Implications for cold fusion will be discussed.

1. Introduction

An early attempt at the University of Ottawa (1) to replicate the work of Fleischmann and Pons (5) failed to produce excess heat. Analyses later found silica in the lithium metal and on both the palladium cathode and platinum anode along with traces of base metals.

Isoperibolic calorimetry (6) describes how heat, generated in a cell, establishes a temperature difference between that cell and its surroundings. Recent work (4) has described how each electrode in this cell may be potted separately with one side exposed to the electrolyte while the other contacts a thermocouple well which is potted in resin. Each half cell can then be treated as a separate isoperibolic electrode calorimeter. However, excess heat was not observed in LiOD.

Therefore, the work was shifted to ordinary water (9,10) where replication of excess heat seemed to be more easily accomplished. However, excess heat was not observed until contaminant silica was added as will be described.

2. Methods

The cell and blank for 0.57M K_2CO_3 in H_2O were 75ml unsilvered dewars. The cathode of 38x40x0.03mm ($30cm^2$) Ni foil was spot welded to 2mm Ni rod and wound as a 5mm pitch spiral with about 1.3 turns. The 10x25mm Pt anode was spot welded to 0.5mm Pt wire. Both Ni and Pt were sheathed above the electrolyte. A 10Ω resistor served as calibration heater immersed in oil in a 5mm OD tube. Separate power supplies provided cell and heater current. The temperatures (of the cells and the bath), voltages and currents were monitored with an Acurex Autograph 800 data logger.

Well aged Ni was prepared for use by smoothing with a wooden dowel, rubbing with fine steel wool, degreasing in alcoholic KOH and coating with silica. Alternatively, it was polished with Tripoli, green rouge and blue rouge before degreasing and coating with 5mg silica.

Ottawa lab distilled water contains only 0.02ppm SiO_2 ; our K_2CO_3 contained 16ppm SiO_2 . Fresh 0.57M K_2CO_3 contained 70ppm. Our best heating so far has been observed in 0.57M K_2CO_3 to which 100ppm SiO_2 and 10ppm $FeCl_3$ were added (Fe first, SiO_2 next, age, and add K_2CO_3). Following use, this solution was found to contain 100ppm SiO_2 .

3. Results

Electrode heating vs input watts is plotted in Fig. 1 as reported elsewhere (4). The lower X-axis reflects the voltages of D_2 and O_2 evolution against Hg/HgO reference electrodes. These voltages project (at zero current) to zero watts on the upper x-axis. The cathodic evolution of D_2 from Pd slopes up to the left (at negative watts) while the anodic evolution of O_2 from Pt slopes up to the right. Fresh metals exhibited the greatest heat per watt. On aged metals, oxygen evolution yielded four times as much heat as hydrogen evolution.

Freshly prepared 0.3N LiOD provided different results. First, stirring was found to reduce cell heating per watt input. Second, both reference electrodes developed bubbles in their capillaries which interfered with their accuracy; bubbles became more numerous as the run progressed. When dismantled, both reference electrodes had white scale at the top of their electrolyte; the scale did not dissolve in acid and was probably silica. No bursts of heat were observed.

In K_2CO_3 electrolyte, cell and calibration heating were equal at first. Heating developed after 100ppm silica was added to the electrolyte. The highest heats seen in Fig. 2 were produced in K_2CO_3 with SiO_2 and $FeCl_3$ present. The sharp rise after the 24 hour calibration occurred when the aged Ni cathode was replaced with a freshly polished and silica coated Ni. The isothermal calibration points required about

two hours each with cell power turned off while resistive heating was fine tuned to hold the cell temperature constant.

Similar results were observed in Na_2CO_3 with SiO_2 and FeCl_3 contrary to the theory of Mills (9).

4. Discussion

Silica, found in chemicals and some lab distilled waters, dissolves from Pyrex at $5\text{mg}/\text{cm}^2/\text{hr}$ in alkaline solution. Its chemistry is complex (3,7). *Various sizes and shapes of particles may exist as stable colloids.* These deposit as a monolayer especially on grease free metal oxides; thereafter, VanDerWaals forces repel other colloidal particles. In a cold fusion cell, electrophoretic forces carry silica to the anode while tri and tetravalent metal ions with a silica sheath move to the cathode. There they cannot stick but form gels which may thicken the solution or adhere to the cell walls depending on their size, shape, porosity and thermophoretic forces. Aging could lead to changes.

Thus, in aged LiOD the calorimeters performed well. In fresh LiOD, silica gel trapped evolving gases which escaped into Luggin capillaries carrying some gel with them. Silica in K_2CO_3 solution, and coated on both Ni and Pt, enhanced the observations of excess heat. This may be true on Pd as well.

Lithium silicate gels at 80°C and dissolves when cooled; this contrasts to sodium and potassium silicates which gel when cold. Thus, operation with warm lithium deuterate could produce a gel and lead to heat retention and bumping.

It is possible that phase shifts in silica deposits could produce fusion products not unlike those observed in Pd-D and Ti-D systems (2,8) *or as trace contaminants from fumaroles and volcanoes (11,12).* Indeed, volcanoes may be produced when silicate rocks undergo phase changes and exhibit related phenomena.

5. Conclusions

It is concluded that four times more heat is generated during the evolution of oxygen from Pt than from the evolution of deuterium from Pd. Silica interfered with some observations and must be controlled before results are certain.

The presence of silica in 0.5M K_2CO_3 and Na_2CO_3 enhanced the observations of excess heat on Ni. A deliberate coating of silica on the anode and cathode also proved beneficial. This silica was also associated with changes in cell calibration constant.

It is concluded further that heating in our cells varied with the condition of silica coating the cathode, with stirring rate and with the

amount of silica that coated the cell walls. While phase changes are anticipated in silica involved in this system, and while such changes may give rise to excess heat and to some nuclear products, it was not determined whether significant heating occurred on anodes, cathodes, cell walls or in solution. Further work is required.

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6. References

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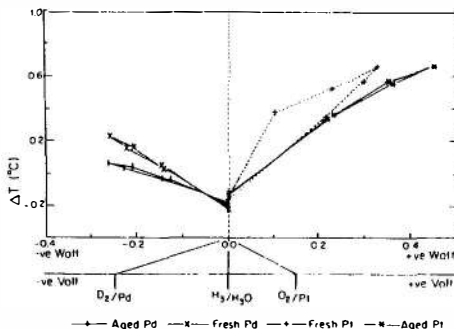


Fig.1. Cathode and anode heating vs wattages as derived from voltages and current.

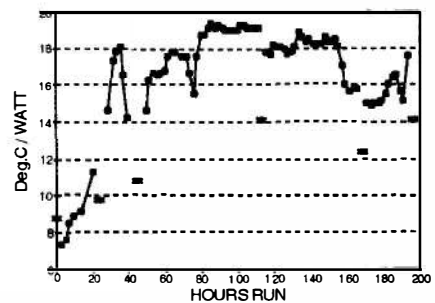


Fig.2. Variations in cell(- - -) and calibr.(x) heating in $K_2CO_3 + SiO_2 + FeCl_3$.