Fabrication, Characterization, and Evaluation of Palladium-Boron Alloys Used in LENR Experiments

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The reproducibility of energy generation from heavy water electrolysis or the Fleischmann-Pons Effect (FPE) depends markedly on the source of the palladium metal used as the cathode. Based on years of research, two sources of palladium materials yielding good reproducible excess enthalpy effects have been identified: (1) palladium-boron materials, and (2) palladium materials prepared by co-deposition method. A common feature for both these methods is that they yield palladium that is free of oxygen as an impurity. This paper deals with the fabrication, characterization, and evaluation of palladium-boron alloys, which have produced excess enthalpy in nearly every experiment [1-2]. Two U.S. Patents have been granted for these materials [3-4].

Palladium has a Face Centered Cubic (FCC) structure with properties akin to gold, i.e., soft, ductile, and resistance to corrosion. The intrinsic hardness and tensile strength of Pd are too low for many applications. The addition of boron to palladium within solubility limit creates two FCC phases with different lattice parameters, one phase being distributed as fine particles within the other phase. The creation of two face centered cubic phases makes the material harder and less susceptible to cracking. That is attractive for some applications. In particular, it is the likely explanation for reproducible energy generation. It is interesting to note that palladium is not tarnished by dry or moist air at room temperature, but at about 600 ^{o}C a thin oxide film forms in air. Above 800 ^{o}C, the superficial oxide decomposes, leaving a clean metal surface. Some oxide formation occurs again above 1000 ^{o}C.

Another beneficial effect of the added boron is that it minimizes the activity of dissolved oxygen in the palladium by converting it to B_2O_3 during processing. The low density B_2O_3 floats to the surface, and is removed during the molten phase of the palladium-boron alloy preparation. The focus of this paper will be to investigate the excess enthalpy production of various compositions of boron in palladium within the solubility limit, including effect of loading of deuterium on grain sizes, developed by annealing for different times at different temperatures, and the extent of cold deformation. Since the mechanical and many other properties of palladium depend on purity, elemental analyses and x-ray diffraction studies will also be presented.

[1] D. D. Dominguez, P. L. Hagans and M.A, Imam, "A summary of NRL Research on Anomalous Effects in Deuterated Palladium Electrochemical Systems", NRL Memorandum Report NRL/MR/6170-96-7803.
[2] M. H. Miles, M. Fleischmann and M.A, Imam, Calorimetric Analysis of a Heavy Water Electrolysis Experiment using a Pd-B Cathode. NRL Memorandum Report NRL/MR/6320-01-8526.
[3] Melvin H. Miles and M. Ashraf Imam, U.S. Patent # 6,764,561, June 20, 2004
[4] Melvin H. Miles and M. Ashraf Imam, U.S. Patent # 7,381,368B2, June 3, 2008