

CIHT Validation Report January 2012  
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This is a report concerning Blacklight Power Corporation (BLP) that I visited on January 4<sup>th</sup> and 5<sup>th</sup>, 2012. The purpose of the visit was to evaluate their technology, and, in particular, BLP's Catalyst Induced Hydrino Transition (CIHT) electrochemical cell for the production of net electrical power using water vapor as the fuel. I oversaw the construction of three nominally identical electrochemical cells with Ni anodes, NiO cathodes, and LiOH-LiBr-MgO electrolytes (source of catalyst to form hydrinos) run under intermittent electrolysis to generate hydrogen at the anode from trace H<sub>2</sub>O flowed into the cell with an argon carrier gas. Control cells comprised K or Na replacing Li or the Li-based electrolyte with no H<sub>2</sub>O under continuous discharge or intermittent electrolysis conditions. The power-engineering and analytical staff with whom I interacted for these demonstrations included Dr. Xingwen Yu, Dr. Guibing Zhao, Dr. Gaosheng Chu, Dr. Jiliang He, and John Lotoski as well as spectroscopist/physicist Dr. Ying Lu. I also had extensive discussions with Randell Mills, the founder, President, and CEO of the company, and Bill Good, the Vice President specializing in business development. I will have more to say about the experiments I oversaw later.

The claim that water can be used to replace fossil fuels in power generation is obviously extraordinary, and extraordinary claims must be backed by extraordinary evidence. First, I discuss the theory developed by Dr. Mills that led him to his conclusions, and then I discussed the empirical data that support the conclusions.

The grand unified classical physics theory of Dr. Mills successfully predicts molecular bond dissociation energies, atomic ionization potentials, the masses of elementary particles, molecular bond lengths and angles, molecular dipole moments, and many others. The fact that these classical calculations have been more accurate and far simpler than sophisticated quantum mechanical calculations has been controversial of course, but what are the novel conclusions of the theory?

One of the most significant predictions of this theory is that hydrogen atoms can catalytically fall to lower electronic binding states (with fractional Rydberg quantum numbers) giving off energy in so doing. This new form of hydrogen has been named hydrino by BLP, and it has been detected in a number of different ways which include upfield proton NMR spectra, soft X-ray continuum radiation from pure hydrogen pinch plasmas, X-ray photoelectron spectroscopy, and Doppler broadening of fast hydrogen in a plasma, the latter of which is particularly compelling. The theoretically expected ro-vibrational spectra of the dihydrino molecule have also been observed. Of most importance, perhaps, the excess energy or power resulting from dihydrino production has been detected by both calorimetry experiments and the electrochemical CIHT experiments to which I referred earlier.

While visiting BLP in Cranbury, NJ in early January, I participated in the construction of three CIHT electrochemical cells and control cells as noted earlier, as well as in the observation of a large number of other cells running in their laboratories on 88 Arbin

Instrument (College Station TX) battery and fuel-cell testing stations. The cells with which I was involved contained Ni anodes although some other cells successfully used Mo as the anode. During their first few days of operation, my cells produced average powers of 3.93, 3.88, and 3.91 mW; whereas, today (a month on) they are producing average powers of 3.46, 3.69, and 3.71 mW, respectively. These cells, nominally identical, were somewhat more reproducible than the dozens of others I analyzed which had average power outputs between approximately 1 and 13 mW having run continuously from days to weeks. During operation, the only mass input to the cells was a flow of humidified Ar, the water vapor supplying the fuel to be electrochemically activated with the hydrogen then converted to hydrino by the Li-based-electrolyte-H<sub>2</sub>O catalyst chemistry that is supported on the Ni or Mo anode. The mentioned controls made no excess electricity; whereas, each Arbin battery testing instrument used to operate the cell and measure the electrical balance as well as a digital oscilloscope calibrated against NIST standards indicated that the catalytically active cells produced greater than 10 times more electricity than they consumed to maintain the intermittent electrolysis over the 30 day run. While at BLP, I witnessed quadrupole mass spectrometric verification of the purity of both the inlet and outlet Ar-water streams. The company has done considerable pre- and post-reaction analysis of the electrodes and electrolytes in an attempt to rule out impurities as a source of the observed power output. None were detected. These measurements are clearly important and need to be continued going forward. Confidence in the absence of any alternative explanation for the excess electricity is improved even more by the increase in power output of the individual and stacked cells that is currently at a level of >1 W. The dihydrino product identification and validation also provides powerful confirmation.

The energy liberated when two hydrogen atoms with principal Rydberg quantum numbers of one are converted by the catalyst to two hydrino atoms with fractional principal quantum numbers of  $n = 1/4$  and then recombined to form a dihydrino molecule is 475.5 eV which is equal to ~46 MJ/mole hydrogen. Since intuitively this is a very large amount of energy, a key question is can we evaluate the reaction rate within each cell and make any inferences or recommendations from the calculated rate.

The energy released when a hydrogen atom is converted to a H(1/4) hydrino is 204 eV/reaction event which is  $3.26 \times 10^{-17}$  J/event. Taking the average power output of my cells, 3.6 mW = 3.6 mJ/s, the reaction rate is found to be  $1.1 \times 10^{14}$  events/s per 11 cm<sup>2</sup> which is the anode surface area on which the catalyst is supported. In the absence of knowledge about the dispersion of the catalyst on the electrode, we must assume that the catalytic area is just the geometrical surface area of the electrode. This means the reaction rate, written in more useful units of flux, is  $1.0 \times 10^{13}$  reaction events/s-cm<sup>2</sup>. The fact that this is quite a low reaction flux is encouraging. We note in passing that gas phase catalytic reaction rates over highly optimized catalysts can easily exceed  $10^{20}$  reactions/s-cm<sup>2</sup>, and diffusion-limited liquid phase catalytic reactions can approach rates of  $10^{23}$  reactions/s-cm<sup>2</sup>.

From a catalytic chemist's point of view, there is an enormous opportunity to increase the reaction rate within the CIHT cells and thus their power output. This opportunity may be

thought of as having two (not independent) parts-geometry and surface reaction rate. The first regards optimization of the geometry to support the reaction at a given surface-area power density. The surface area of the dispersed catalyst can be synthesized to be several orders of magnitude greater than the geometrical surface area onto which it is supported, and the volumetric power density can also be increased by orders of magnitude by developing thinner electrodes and electrolyte layers of cells of a stack. Secondly, and potentially more important, the supported catalyst can, in principle, be optimized to yield a reaction rate that is orders of magnitude greater than  $10^{14}$  reactions/s to yield a much higher surface-area power density.

A combination of increasing the surface area of the supported catalyst and improving/optimizing the supported catalyst could increase the power output of a single CIHT cell by many orders of magnitude. In the former case, using the power density of about  $3 \text{ mW/cm}^2$  of the Mo-anode cell and a thickness of each cell of a stack of 30 microns, the projected power density is 1 kW/l. Furthermore, the  $3 \text{ mW/cm}^2$  based on the geometrical surface area of the Mo electrode can be increased by large factors by using textured materials with much larger surface areas than the geometrical surface areas. Moreover, an improvement of five orders of magnitude, which is not unprecedented in the heterogeneous catalysis literature between the first “hit” and the optimized catalyst, would result in a 3.6 mW test cell becoming a 360 W cell, and a mere ten of these cells stacked together would produce 3.6 kW. Further “numbering up” of these cells would produce even greater power, as needed. The R&D challenges to achieve this goal appears to be straight forward, but nontrivial. I recommend adding an experienced catalytic scientist to the team as well as an experienced electrical engineer for the stacked cell product.

To summarize, when first hearing of the claims of BLP, it would be irrational not to be very skeptical, and prior to meeting Randy Mills I was extremely skeptical. However, after having visited BLP, having participated in experimental design and execution, and having reviewed vast amounts of other data they have produced, I have found nothing that warrants rejection of their extraordinary claims. On balance, I recommend continued funding of BLP for at least another 24 months while they engage in catalyst optimization research and CIHT cell “numbering up” development. To be able to use hydrogen from water as a cheap and nonpolluting source of power would represent one of the most important technological breakthroughs in history.

This CONFIDENTIAL report was prepared in final form by Dr. W. Henry Weinberg in Santa Barbara, California on February 4, 2012.

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