bridging the gaps

Sustainable Urban Spaces

MSc Competition 2008

UCL

A Novel Hydride Fuel Cell Hybrid for Zero Emission Vehicles

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INTRODUCTION

Hydrogen fuel cells are increasingly being viewed as an alternative to the use of fossil fuels in powering vehicles as they only produce water as a by-product during operation. Hydrogen as a fuel for mobile applications has a problem with the method of storage, currently various methods exist such as pressurised tanks, liquefied hydrogen, metal hydrides and also chemically bonded in chemical compounds such as methane. This project demonstrates the feasibility of using a metal hydride to store the hydrogen, but in contrast to the traditional methods of having the metal hydride stored separately it will be attached to the anode. This implies that the metal hydride will be part of the fuel cell arrangement.

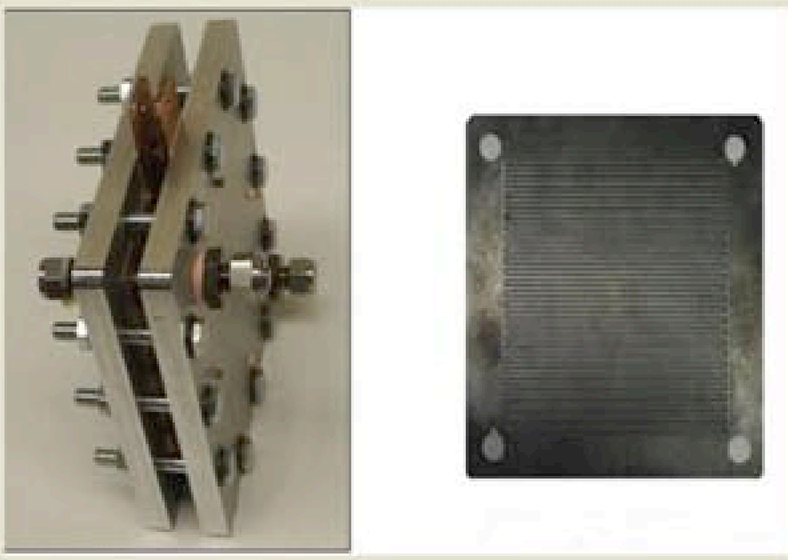

Fig. 1. A Polymer Electrolyte Fuel Cell developed as part of this project, alongside a graphite bipolar plate.

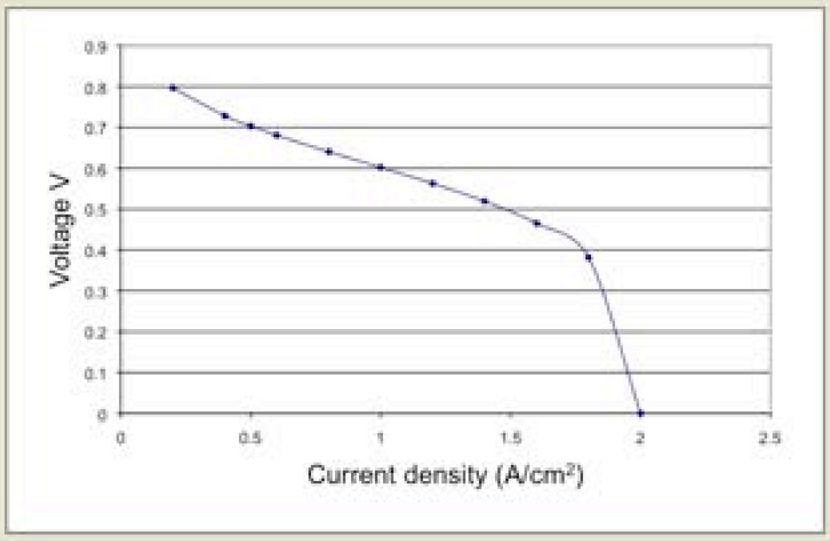

Fig. 2. A Standard PEM Fuel Cell Polarization curve

EXPERIMENTAL RESULTS

In demonstrating the feasibility of this method of storage and operation, the sample metal hydride (lanthanum nickel hydride – $LaNi_5H_6$) is prepared (Dept. Chemistry) and integrated directly into the channels of the bipolar plate in contact with the anode (Fig. 1.). A complete test stand was constructed for the purposes of this project which allowed the electrochemistry of a conventional cell fuelled with hydrogen to be recorded in order to obtain polarization curves which are compared with the performance of the hybrid hydride fuel cell. Figure 2 shows the results obtained for the fuel cell operating in conventional mode.

MODELLING RESULTS

The thermal management of a cell operating in hydride hybridised more is vital for effective operation. Enough heat needs to be liberated during fuel cell operation to service the endothermic hydrogen liberation reaction. It is effectively the heat available from the fuel cell that controls the hydrogen supplied to the anode. A model has been developed to assess if fuel cell heat (Ohmic and thermodynamic) is sufficient to overcome the heat of reaction required for hydrogen liberation. The model developed considers heat transfer, mass and heat balance, the electrochemical reaction and the thermodynamics of hydrogen liberation form the metal hydride. Figure 3 shows the excess heat available from the cell. Over a range of current densities. It is clear that sufficient heat is available to across the operating range to maintain the reaction. The concept is therefore realistic on thermodynamic. Ongoing work is looking at the kinetics.

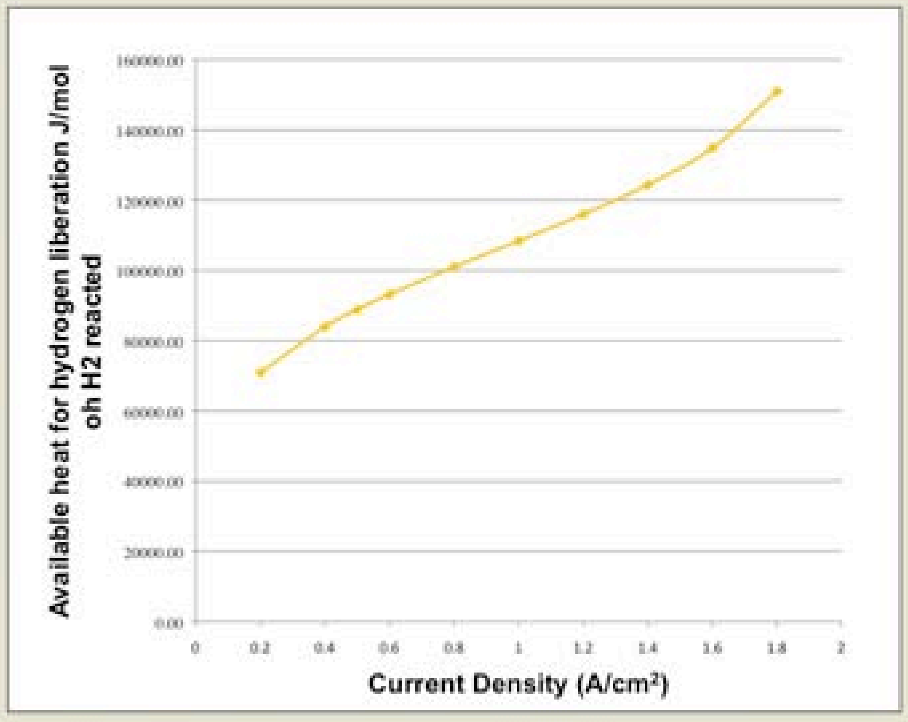

Fig. 3. Excess heat produced by the fuel cell