TUESDAY, AUGUST 23, 2005, A.M.

SESSION 11A: INTERNATIONAL SYMPOSIUM ON FUEL CELL AND HYDROGEN TECHNOLOGIES

PEMFC DIAGNOTICS AND EVALUTATION II
Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM
Room: Imperial Ballroom 5
Chairmen: J. STUMPER, Ballard Power Systems, Canada and
D. GHOSH, NRC Institute for Fuel Cell Innovation, Canada

PAPER 11A.1 — 8:20 (KEYNOTE)
CURRENT PERSPECTIVES ON FUEL CELL RESEARCH AND DEVELOPMENT.
D.P. WILKINSON, University of British Columbia, Canada

There are significant global environmental and supply issues with existing energy paths today. Global emission and fuel regulations, global fuel and power structure, energy security, and cost are driving new technology and non-conventional approaches. Fuel cells will play a significant role in the strategy to effect positive global change, increase fuel efficiency and decrease dependency on traditional fossil fuels. Fuel cells do not require recharging; just refuelling and a wide range of fuels are possible with hydrogen being the most desirable. Technical progress as well as investments in fuel cells for transportation, stationary, portable, and micro fuel cell applications have been dramatic in recent years. The present view is very optimistic for fuel cell power generation and the status is presently at the field trial level, or early commercialization stage, moving into volume commercialization. A number of demonstration programs are in progress worldwide such as the California Fuel Cell Partnership which involves original equipment manufacturers (OEMs), fuel providers, transit authorities, and state and government bodies. Fuel cells and a hydrogen infrastructure are key to a long-term solution to global energy issues. Fuel cells will need to be competitive on an economic basis with the established and highly developed internal combustion engine and other forms of power generation. There has been significant technical progress in a number of fuel cell areas including power density, transient / dynamic response, multiple fuels, cost potential, reliability and durability. However, significant technology gaps still remain today. This presentation will focus on the status and progress of the fuel cell today, current fuel cell research and development, the challenges going forward, and the future view of the fuel cell and its impact on global energy issues.

PAPER 11A.2 — 8:40 (INVITED)
SYSTEMATIC AND COMPREHENSIVE MODELLING/SIMULATION OF PEMFC CELLS AND STACKS.
X. LI, University of Waterloo, Canada

Polymer electrolyte membrane (PEM) fuel cell has increasingly become the potential choice of zero-emission power source for portable, mobile and stationary co-generation applications. However, technical barriers need to be overcome before its widespread commercialization; cost reduction and performance improvement including reliability are the two key areas, that can be realized through better cell/stack design and improved understanding of the transport processes occurring inside the individual cells and stacks. In this presentation, we will provide an overview of various cell/stack models that are available in the literature, their strength and weakness, and then present a comprehensive multi-species, multi-phase and multi-dimensional formulation of a single PEM fuel cell, with consistent and systematic formulation for all the regions involved, including the solid bipolar plates, gas flow channels, the electrode backing layers, the catalyst layers and the electrolyte membrane. Such a detailed approach allows us to extract sufficient information to the analysis of a stack of PEM fuel cells. Stack model will be presented that investigates the various stack designs and flow configurations, and the optimal stack design based on the present study will be described. Also some innovative cell/stack designs will be featured.

PAPER 11A.3 — 9:00
MAGNETIC RESONANCE IMAGING OF OPERATING H2/O2 FUEL CELLS AND TOWARDS RECHARGEABLE 2-PROPANOL FUEL CELLS.
K. FEINDEL, L.P.-A. LAROCQUE, D. CAO, R. DU, R.E. WASYLISHEN and S.H. BERGENS, University of Alberta, Canada

Part I: The distribution of water in operating fuel cells must be carefully managed to optimize the performance, durability, and functionality of the system. For example, the ionic conductivity of polymer electrolyte membranes decreases as membrane hydration is reduced. Flooding at the cathode inhibits mass transport, and it can lead to failure of materials. Build up of liquid water in the gas flow channels of a fuel cell stack will create a non-uniform distribution

of pressure drops across the individual cells. We will discuss the application of ^{1}H NMR microscopy to investigate in situ the production and distribution of water throughout an operating H_2/O_2 polymer electrolyte membrane fuel cell.

Part II: Polymer electrolyte direct methanol fuel cells posses high theoretical storage capacities as power systems for portable electronic devices. There are, however, two long-standing hurdles to development of practical methanol fuel cell systems. First, the electro oxidation of methanol at the anode of the fuel cell is poisoned by absorbed carbon monoxide, an intermediate in methanol electro oxidation. Second, methanol readily crosses over from the anode to the cathode of the fuel cell. This methanol crossover wastes fuel, and it poisons the electro reduction of oxygen at the cathode. We are investigating use of 2-propanol as an alternative to methanol as a fuel. 2-Propanol is less toxic than methanol, and it is less prone to crossover from the anode to the cathode. More significant, however, is that the electro oxidation of 2-propanol to acetone is faster than the electro oxidation of methanol because it avoids formation of adsorbed carbon monoxide. We will present active catalyst systems for the electro oxidation of 2-propanol to acetone in fuel cells. We will also present methods to convert the resulting acetone back into 2-propanol, possibly leading towards rechargeable portable fuel cell systems.

PAPER 11A.4 — 9:20

MEASUREMENTS AND MODELLING OF REACTANT/COOLANT FLOW DISTRIBUTION IN FLOW FIELD CHANNELS.

C. GU, M. BLANCO, J. MARTIN, J. SHEN, J. ZHANG, H. WANG, NRC Institute for Fuel Cell Innovation, Canada

D.P. WILKINSON, University of British Columbia, Canada

Flow field design is critical for PEM fuel cells as it can affect reactant distribution to the catalyst surface, water management, thermal management and current collection. Therefore, it has tremendous impacts on fuel cell performance and durability, reliability and operational flexibility. In this paper, an optical method is used to study the reactant distribution in the flow field channels of two commonly used flow field designs: straight channel design and serpentine channel design. Images of the observed flow patterns are presented and discussed.

PAPER 11A.5 — 9:40

ACTIVE AREA CONTROL IN A FUEL CELL FLOW FIELD.

M. BLANCO, R. RAHBARI, J. ZIMMERMANN, NRC Institute for Fuel Cell Innovation, Canada and

D.P. WILKINSON, University of British Columbia, Canada

Flow field design is critical to determining fuel cell performance with respect to operating conditions. Flow fields are normally designed around their maximum power operating point with the goals of maximizing performance and minimizing pressure drop between the inlet and outlet of the flow field. At lower power pressure drop is reduced, and water management and reactant distribution issues can occur over the active area as well as issues with cell to cell reactant distribution in the fuel cell stack. Flow fields have fixed flow channel geometries and fixed active areas which determine the reactant flow characteristics over the operational range of the fuel cell. In this paper we discuss some of the benefits of a new approach of changing the flow field active area with changing operating conditions. Such benefits for future fuel cell designs could include improved cell performance and stability, improved cell to cell reactant distribution, reduced low current density failure modes, and overall system advantages.

COFFEE BREAK — 10:00 – 10:20