Advances in Selected Fuel Cell Technologies: Summary of a Panel Session Presentation

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***Abstract*—The presentation will focus on two types of fuel cells: solid-oxide and direct-methanol. Solid-oxide fuel cell (SOFC) systems, based on either a tubular or planar electrode configuration, operate in the temperature range of 750 to 1,000 degrees C and were reviewed in 2004. This session will provide updates on prior SOFC material and introduce two new early-stage SOFC technology developments. Direct-Methanol Fuel Cell (DMFC) systems do not require a reformer to produce the hydrogen-rich fuel needed by most low-temperature fuel-cell systems. DMFC systems are being developed in a wide range of sizes, from laptop and cellular phone batteries to electric vehicles – units. – This presentation will describe the basic design and characteristics of DMFC systems in development for residential and commercial applications.**

***Index Terms*—fuel cell, cogeneration, solid-oxide, SOFC, direct-methanol, DMFC, ceramic electrolyte.**

I. INTRODUCTION

THIS panel session presentation summary provides an overview of the efforts under way to develop direct-methanol fuel cell (DMFC) systems for a wide range of power ratings and applications. Methanol is a common industrial chemical that is easily stored at room temperature and atmospheric pressure, in contrast to natural gas – the most common fuel cell feedstock. General DMFC system configurations and operating parameters will be discussed.

Existing SOFC companies and types of products will be surveyed, with results presented in tabular form as in 2004. The new SOFC technology developments are only described in general terms because of proprietary concerns. Developments
at CeramPhysics and Rolls Royce are characterized as modular, scaleable and mass-producible at low cost.

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II. OVERVIEW OF SOFC COMPANIES

Table 1 below lists companies with SOFC activities examined in the 2004 session. In many cases, progress has been made in product development and will be noted accordingly. Companies have pursued variations on each type of cell configuration, tubular and planar, so a standard form of either has not emerged to date. For illustrative purposes, an example of the tubular fuel cell configuration employed by one manufacturer is shown in Figure 1.

TABLE I
SOFC COMPANIES AND PRODUCTS AS OF 2004

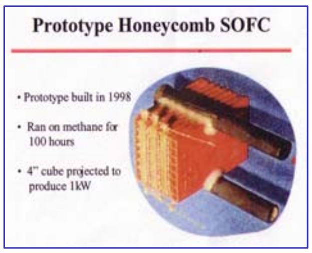
Company	**Power**	**Cell Type**
Acumentrics	2-10 kW	Tubular
Ceramic Fuel Cells Ltd	<50 Kw	Planar
Delphi Corp.	1-25 kW	Planar
Fuel Cell Technologies	5 kW	Tubular
Global Thermoelectric/ Quantum Fuel Systems	2-5 kW	Planar
Sulzer Hexis	1 kW	Planar
Siemens/Westinghouse	125 kW	Tubular
Rolls-Royce	250 kW	Planar
Ztek	25 kW	Planar

FIGURE 1
PHOTO OF TUBULAR SOLID-OXIDE FUEL CELLS*

* Photo courtesy of Acumentrics, Inc..

III. NOVEL SOFC CONCEPTS IN DEVELOPMENT

CeramPhysics, Inc. (CPI) has been developing their SOFC technology for over ten years. This fuel cell stack uses an inexpensive manufacturing platform and operates at less than 600 degrees C. By using this lower operating temperature, the cost for materials and seals is greatly reduced compared to the more traditional high temperature SOFCs. The CPI design is based on an extruded honeycomb of stabilized bismuth oxide. The stack manufacturing process utilizes methods developed for vehicle catalytic converters, which is the basis for the low projected cost. A 1 kW fuel cell stack is expected to cost about $70 and approximate a 4-inch cube in size. CPI- has demonstrated the concept through successful operation of a bench scale model on methane.



Rolls Royce has been developing a modular hybrid device that integrates a gas turbine with planar SOFC technology. The expected product goal is a highly efficient generator that will be scaleable for stationary application. Currently, Rolls Royce is working on a modular 1-MW system that incorporates 900-kW SOFC with 100-kW turbine technologies. The design objective is to develop a low-cost, high-durability, energy- efficient generator. They anticipate commercialization of the 1 MW unit in late 2008 2007 with a cost-competitive device. That plant is modular in design consisting of four 250-kW hybrids. Milestone objectives include a 60-kW demonstration (without a turbine) in 2005 and an operational 250kW prototype (with a turbine) in lateat the end of 2006.

IV. DIRECT-METHANOL FUEL CELLS

Although the DMFC technology can operate without a reformer, there are a number of operating problems to address. One major challenge is maintaining the desired concentrations of fluids (primarily methanol and water) on each side of the catalyzed membrane. Water is required on the anode (fuel) side to react with methanol, but water is produced on the cathode (exhaust) side of the fuel cell membrane. Maintaining this water balance is difficult but can be accomplished in several ways. Design of the membrane electrode assembly (MEA) focuses on balancing the cost and effectiveness of various catalysts while allowing satisfactory proton diffusion but maintaining desired fluid concentrations.

As with SOFC technology, there are companies developing DMFC systems targeted at specific niche markets. Battery replacement options are perhaps highest on the list, since DMFC systems can provide on the order of ten times the energy density of batteries. The presentation will provide an overview of companies active in the DMFC field and the range of products under development. 05GM-JB&DN-PSPS_V84.DOC

V. BIOGRAPHIESIOGRAPHIES

JOHN J. BZURA (M-1980, SM – 1989) was born in Albany, Georgia, on September 14, 1944. He received the B.S., M.E.E. and Ph.D. degrees from Cornell University in electrical engineering and an M.B.A. degree from Syracuse University.

Dr. Bzura was employed by Arthur D. Little, Inc. from 1974 to 1983 in the Physical Systems Research Group. He joined the New England Power Service Company (now National Grid USA Service Company) in 1983, and spent 10 years as Principal Engineer in the Demand Planning R&D Group. The last 11 years have been with the R&D / Technology Transfer group; evaluation of DG technologies and DG interconnection issues have been high priorities.

He is a Senior Member of the IEEE Power Engineering Society and serves as Chairman of the Distributed Generation and Energy Storage (DG&ES) Working Group within the Energy Development Subcommittee.

DAVID K. NICHOLS holds a BSEE degree from Akron University. He began work at American Electric Power in 1972. He transferred to the Electrical Laboratory in 1976 and has held various managerial positions in AEP's Corporate Technology Development. He is currently manager of AEP's Dolan Technology Center in Groveport, Ohio. A specialist in high-voltage electrical and mechanical equipment, Nichols oversees research and development projects, including several distributed resource and energy storage projects. Nichols is a member of IEEE.

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