

14th Annual International Symposium

Hybrid Small Fuel Cells 2012

July 18, 2012
Boston, MA USA

Hybrid Fuel Cell/Battery Systems for Commercial & Military Applications

In its 14th year this One-Day Special Symposium in Small Fuel Cells meeting series is the primary source of information for end-users, developers and manufacturers of hybrid fuel cell/battery devices across fuel types, system architectures, and power ranges. With an impressive lineup of speakers this year's event presents the change in paradigm in the approach to fuel cells development and application and is not to be missed. Program topics will include:

- Fuel cell paradigm change – emphasis on hybrid fuel cell/battery systems
- Hybrid fuel cells batteries by design – application driven development
- Micro fuel cells hybrid / battery devices for mobile electronics and handheld electronics
- Advances in automotive hybrid fuel cells / battery systems development and application
- System integration & balance of plant engineering
- How much is enough of battery control in fuel cell hybrid system?
- Hybridization of PEM, SOFC & DMFC
- Advances in fuel development
- Materials challenges and use of materials-by-design approach
- Role of nanotechnology & nanomaterials
- Safety, durability & reliability



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July 18, 2012

Symposium Agenda

Wednesday, July 18, 2012

8:00 *Registration, Exhibit Viewing/Poster Setup, Coffee and Pastries*

9:00 **Organizer's Welcome and Opening Remarks**

9:10 **Powering the Next Generation of Portable Devices: New Concepts in Fuel Cells and Hybrid Systems**

Sanjeev Mukerjee, PhD, Professor, Dept of Chemistry; Director, Center for Renewable Energy Technology, Northeastern University

Abstract is not available at time of printing. Visit www.KnowledgeFoundation.com for the latest Program updates.

9:45 **Performance and Reliability of Portable DMFC System for Soldier Power Application**

*Inseob Song, PhD, Fuel Cell Group Leader, Principal Engineer, Samsung SDI Co., Ltd., Korea**

The portable hybrid DMFC system for soldier power application will be presented. All of the military standards for soldier power were finally passed. And the authors would like to share the performance and reliability characteristics of portable DMFC system showing that this technology moves one step forward to commercialization of portable fuel cell.
**In collaboration with: Hyejung Cho, and Jeongkurn Park*

10:15 **Fuel Cell Powered Hearing Aids**

Jan H. Hales, PhD, Centre for Microtechnology and Surface Analysis, Danish Technological Institute, Denmark

Hearing aid users are faced with the dexterity challenge of frequently replacing the small button cell batteries. This challenge becomes more pronounced as the energy demand of new hearing aids increases with functionality. The presented research addresses the replacement of zinc-air batteries with methanol based micro fuel cells. The presentation will focus on the development towards pilot production from the perspective of the involved research on large scale synthesis of catalytic nanoparticles and advanced fuel cell encapsulation.

10:45 *Networking Refreshment Break, Exhibit/Poster Viewing*

11:15 **PEMFC Plug-In Serial Hybrid Powertrain**

Alfredo Picano, CEO, Labor S.r.l., Italy

FEMAG-C is a zero emission, plug-in, serial hybrid power train, powered by PEM fuel cells, with metal hydrides hydrogen storage; the plug-in hybrid architecture allows to recharge the battery pack from the grid, and use the hydrogen-powered generator to extend the range of the vehicle; it can supply 3 kW nominal power and up to 10 kW peak power, storing 12 kWh of energy in a weight of 80 kg

11:45 **Lightweight Hydrogen Cartridges for PEMFC**

Stephen Voller, CEO, Cella Energy, United Kingdom

Cella Energy's portable power division is based at the NASA Kennedy Space Centre in Florida. The company is developing new lightweight hydrogen cartridges that can be used with PEM fuel cells as battery charges or range extenders for smartphones, cloud computing devices, laptops and for the military. Cella's patented technology changes the properties of complex hydrides so the hydrogen is released quickly and cleanly. Once produced the Cella materials look like Kleenex or tissue paper.

12:15 **Selected Oral Poster Highlights**

12:30 *Lunch*

2:00 **Developing Soldier Wearable Fuel Cell Power Source at ARL**

Xiaoming Ren, PhD, U.S. Army Research Laboratory

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2:30 **Development of a Low Cost, Highly Flexible Fuel Cell – Battery Hybrid Power Architecture**

Shane Slater, PhD, CEO, LightGreen Power, United Kingdom

The capital cost and durability of fuel cells remain barriers to deployment. Many applications have an intermittent load profile, such as off-grid power, robotics, and electric flight. The characteristic high peak/average power can result in destructive on-off fuel cell cycling and early failure. A novel hybridisation architecture has been developed which permits smaller, cost effective fuel cells to be used in high power applications while improving durability. A key innovation is DC-DC conversion with variable voltage and current. This permits complete control, allowing modulation of the fuel cell output to improve duty cycle requirements and significantly improve lifetimes. Key advantages are lower cost, improved fuel cell durability, inclusion of diverse fuel cell / power generators, and simple, software based system configuration. The hybrid architecture has been deployed commercially in the LightGreen Power Micro and Hyball systems with fuel cells from 50-500W producing up to 3kW.

3:00 **A Novel Proton Exchange Membrane Fuel Cell-Battery Partial Hybrid System Design for Unmanned Aerial Vehicle (UAV) Application**

Maheboob (Mebs) Virji, Hawaii Natural Energy Institute (HNEI), University of Hawaii

A novel partial FCB hybrid system has been designed to have flexible modes of operation which would allow the fuel cell and the battery to share the peak power for extended periods, operate the fuel cell stack at much lower and better controlled dynamics and minimize the system losses. A prototype hardware controller has been designed and built to working in conjunction with the control algorithm of the partial hybrid

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system to enable the use of a smaller charging DC/DC converter and "Zero-Volt" diode control switches to reduce the overall system losses.

3:30 *Networking Refreshment Break, Exhibit/Poster Viewing*

4:00 **Portable LPG-Fueled Microtubular SOFC**
Sascha Kuehn, PhD, Managing Director, eZelleron GmbH, Germany

The demand for mobile power increases steadily. Mobile devices always seem to be out of power exactly when you need them. Batteries can fulfill the users "thirst" for power only in a short term range. Batteries need a long-term non-mobile recharging time. Thus, for the long-term mobile power supply without recharging interruptions or for mobile recharging of devices gasbatteries are the best choice. eZelleron's gasbattery is a hybrid system of battery and fuel cell. For the user it feels like a standard battery with up to 30 times more energy per weight than a battery. The fuel cell can be easily fueled by everywhere available gases like propane, butane, campinggas or LPG. The fuel cell is a Solid Oxide Fuel Cell (SOFC), bringing the advantage of fuel flexibility and being free from noble metals. However, SOFCs have known issues, like slow start-up and bad cyclability. In this presentation it is shown, how to overcome these issues by engineering the microstructure. The mass-manufactured eZelleron microtubular SOFC is operational within seconds. Hence this is a potential technology for mobile/portable power supply of devices.

4:30 **Mixed Ionic-Electronic Conducting Oxide with K_2NiF_4 Type Structure, Potential Cathode Material With for Intermediate Solid Oxide Fuel Cells**

Mirela Dragan, PhD, Researcher, University of Connecticut

Mixed ionic-electronic conductors (MIECs) have received considerable interest over the last few years because of their applicability as oxygen-transporting membranes because they can be used in a wide range of applications such as cathode materials in solid-oxide fuel cells, the partial oxidation of methane to syngas, the production of high purity oxygen, in petrochemical processes such as the oxidative coupling of

methane to ethylene or ethane. During of oxygen transport two basic processes occur in a single-phase ceramic material at steady state are discussed. In the bulk, coupled diffusion of oxygen ions and electrons takes place, while exchange reaction of oxygen from the lattice with molecular oxygen in the gas phase occurs at both interfaces of the membrane. Ceramic oxides materials with perovskite related structures, like the K_2NiF_4 structure have been reported to exhibit substantial oxygen permeation flux, which makes these attractive candidates for high-temperature oxygen separation. In contrast to perovskite type membranes, the oxygen flux in these materials is believed to be supported by oxygen interstitial ions. In this work mixed ionic-electronic conducting oxide with K_2NiF_4 type structure is evaluated with respect to the transport properties, stability in different atmospheres and the aging.

5:00 **Integrated Fuel Cell / Battery Mobile Energy Systems**

Salvatore J. Pace, PhD, Independent Consultant in Fuel Cell/Battery Technology

Arguably, a most promising technology for mobile energy systems is the integrated fuel cell/ battery system. However, the integration of source energy functions does not go far enough in achieving the efficiency necessary to provide a significant alternative for future transport systems (automobiles). Taking a cue from nature, energy source and function are closely coupled and confined to a single cell (where selective energy transfer and actuation or other function occurs). By adapting the tools of micro-fabrication and nanotechnology we can configure integrated system platforms that couple energy source and actuation as self-contained continuously refueled systems that mimic nature. Fuel cells are well suited for integrated electric motor design. Such systems may be fueled by Nat Gas/Air or other renewable fuels. Furthermore, the development of such motor/fuel cell platforms would provide the discovery mechanism for catalysis, the key to energy efficiency for such systems.

5:30 **Moderated Discussion: Fuel Cells for Portable and Mobile Power: Is the Dream Still Alive?**

6:00 *End of Symposium*

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