Technical advances improve the potential for a fuel cell which eliminates the need to store or generate hydrogen

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Direct Methanol Fuel Cell

Challenge

Direct Methanol Fuel Cells (DMFCs) can be a viable power source in many applications if their power density, energy conversion efficiency, and fuel utilization can be increased, while also reducing their cost. To realize these improvements, two critical challenges must be resolved: (1) lowering the required amount, or "loading," of platinum catalyst while achieving a high current (power density) level, and (2) eliminating the crossover of methanol through the membrane, a process that decreases the air cathode's performance and wastes fuel.

30-cell 45-cm^2 direct methanol fuel cell stack.

Technology Description

Similar to polymer electrolyte membrane (PEM) fuel cells powered directly by hydrogen or by reformate (hydrogen-rich gas produced by reforming liquid fuels), in DMFCs oxygen from the surrounding air is reduced at the cathode, but liquid methanol, instead of hydrogen, is the fuel oxidized directly at the anode. Therefore a DMFC system does not require a hydrogen storage tank or reformer, which is why DMFC systems could be an attractive alternative to direct hydrogen or reformate systems.

Accomplishments

Work on DMFC designs has focused on the tradeoff between reducing platinum catalyst loading and peak power. Platinum catalyst loadings have been reduced by over a factor of ten, with only a 30% reduction in peak power. For example, at a platinum loading of 2 g Pt/kW, a peak power level of 0.12 W/cm^2 was demonstrated.

New hardware developed and used in a 30-cell fuel stack with a 50-cm^2 cross-sectional area produced 80 W of power at near ambient operating temperature and pressure. The projected output power at higher operating conditions (90° C and 30 psig) is 200 W.

A DMFC system was successfully operated using factory-grade methanol without further purification. This indicates that special "fuel cell grade" fuel will not be required for DMFCs.

Benefits

A Direct Methanol Fuel Cell offers a number of advantages, including:

- Using a liquid fuel for power.
- A simpler system design, with the potential for low-volume, lightweight packaging.
- Eliminating the requirement for fuel reforming and/or onboard hydrogen storage.
- Classification as a zero-emission power system.

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Commercialization

Motorola and Los Alamos National Laboratory (LANL) collaborated in establishing a DMFC Research Center at LANL to develop DMFCs for portable power applications, such as cellular phones and laptop computers. Mechanical Technology, Inc. has licensed the LANL DMFC technology and spun off a company to commercialize DMFC for portable power applications. Commercial interest also exists for DMFCs in remote and auxiliary power applications ranging from low-power instrumentation to higher power (5 kW) auxiliary units in cars and trucks. The military is also interested in DMFCs as a battery replacement for combat personnel and for battlefield applications. The Defense Advanced Research Projects Agency (DARPA) is collaborating with the U.S. Department of Energy (DOE) in sponsoring DMFC research and development.

Future Activities

Research and development efforts on DMFC systems will aim at further lowering precious metal requirements while improving power density. To address water management and system level issues, fuel cell stacks will be scaled up to 1 kW peak power. Long-term operation and durability testing will be initiated.

Partners in Success

- U.S. Department of Defense - DARPA
- Los Alamos National Laboratory