Unique, molded composite plates offer high performance and lower cost ($10/kW)

OAAT ACCOMPLISHMENTS

Molded Bipolar Separator Plates for Fuel Cells

Challenge

Graphite bipolar separator plates are one of the more expensive components in polymer electrolyte membrane (PEM) fuel cells designed to power automobiles. Using less expensive materials and simplifying the manufacturing process would reduce the cost of bipolar separator plates. However, any change in design must be introduced without compromising fuel cell stack performance.

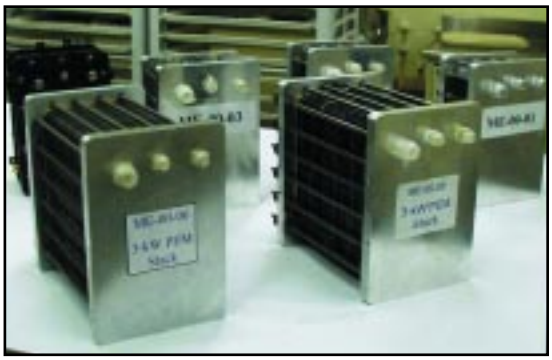
Technology Description

As a substitute for conventional graphite bipolar plates, U.S. Department of Energy (DOE) researchers selected, blended, and optimized inexpensive raw materials to achieve the electrical, chemical, and physical properties needed for fuel cell stacks. Moldable blends of graphites, resins, and additives were identified and used for molding composite graphite bipolar plates. Molding the plates avoids the expense associated with conventional machining and finishing of the typically complex separator plate shapes. The new plates were manufactured in a pilot production molding line and then tested (as assembled fuel cell stacks) for functional performance and endurance under typical vehicle operating conditions.

Accomplishments

The molded plates were shown to meet or exceed specified properties for conductivity, corrosion, and hydrogen (fuel) permeability. They also demonstrated good performance during crush strength, flexibility, total creep, flexural strength, and combustibility testing. Overall plate performance, measured in millivolts (mV) of electrical output, closely followed that of conventional, machined plates at typical current densities around 400 mA/cm^2. At higher currents, the molded plates actually performed better, because their hydrophilic nature accelerates draining of the by-product water produced during the electrochemical reaction inside the fuel cell stack.

Researchers, using a pilot production line, have produced up to five plates per hour. A full-size production line, incorporating less expensive materials and more efficient manufacturing processes, could reduce the cost of bipolar plates to $10/kW (assuming a production level equal to at least 100 megawatts annually, which is the capacity needed for 2,000 fuel cell cars each with a 50-kW fuel cell engine).



7-, 20-, and 52-cell molded bipolar plate fuel cell stacks.

Molded composite graphite plates were assembled into multicell stacks of 4, 7, 20 and 52 cells, which were tested under normal vehicle operating conditions during continuous and intermittent operation. The 20-cell fuel stacks achieved 2,300 operating hours and, some plates were reused with no changes in chemical or mechanical properties for over 5,000 hours.

Contacts

Donna Lee Ho
Manager, Fuel Cell Systems
202-586-8000
202-586-9811 fax
donna.ho@ee.doe.gov

Leonard G. Marianowski
Gas Technology Institute (GTI)
847-768-0559
847-768-0916 fax
len.marianowski@gastechnology.org

Benefits

Using molded bipolar plates enables fuel cell developers to design more affordable, compact, and lighter fuel cell stacks without compromising the performance of the fuel cell system.

The molded plates are very strong – capable of withstanding holding forces up to 200-psi pressure inside the fuel cell stack – and are able to flex slightly, which produces a more durable and rugged stack. The thinner construction of the molded plates also allows producing more complex designs.

Molded plates can be produced faster in high-volume manufacturing environments and at considerably less cost, as low as $10 per kilowatt (kW).

Commercialization

Two of the original partners in the research, Stimsonite and ENDESCO Services, formed a new company, PEM Plates, to produce commercial molded composite graphite bipolar separator plates. To date, the company has operated a pre-commercial molding line producing up to five plates per hour. PEM Plates expects to achieve per-plate costs of $10/kW by using bulk materials that cost $4/kW and limiting production costs to $6/kW, based on projected annual plate orders needed for 2,000 cars each with a 50-kW fuel cell engine.

Future Activities

Efforts will continue to document the increased longevity and superior performance of molded bipolar separator plates in fuel cell stacks. Researchers will also increase the capacity of the pilot molding line and incorporate process improvements. The capability of the molded plates to support new fuel cell stack configurations will be promoted to encourage commercial fuel stack developers to adopt the molded plate technology.

Partners in Success

- Argonne National Laboratory
- Honeywell, Inc.
- Gas Technology Institute (GTI)
- PEM Plates, LLC (collaboration of Stimsonite and ENDESCO Services)
- Superior Graphite Corporation