

FARADAYIC ElectroEtching of Stainless Steel Bipolar Plates

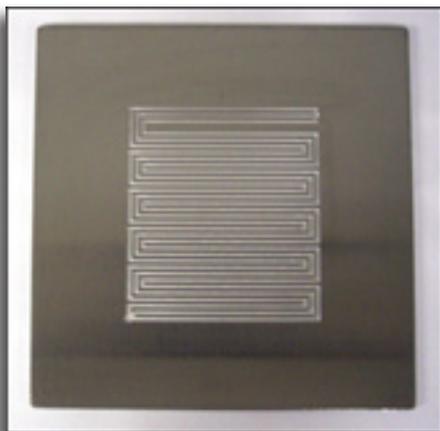
Emerging Technology

New Manufacturing Process Enables Low-Cost, High-Volume Production of Metal Bipolar Plates

The transition of PEM fuel cells to the commercial market requires low-cost components, materials and manufacturing processes. Considering that bipolar plate manufacturing currently contributes to a significant percentage of the total fuel cell manufacturing cost, an inexpensive bipolar plate manufacturing process must be realized for fuel cells to achieve prominence in the commercial energy sector. The use of metal as a bipolar plate material is attractive because of its high electrical conductivity. Since candidate materials such as titanium, tantalum and gold are too expensive, stainless steel alloys are being considered for bipolar plates. Stainless steel bipolar plates offer several additional advantages such as relatively low cost, high strength, ease of manufacture and significant improvements in the power/volume ratio since they can be shaped into thin sheets.

Using funding from the Department of Energy's Hydrogen, Fuel Cells & Infrastructure Technologies Program, Faraday Technology is developing a low-cost, high-volume metal bipolar plate manufacturing process. The new manufacturing process, the FARADAYIC ElectroEtching Process, is based on electrochemical through-mask etching. The process involves patterning a photoresist mask on the surface of the bipolar plate to protect specific areas during the electroetching process. A pulsed electric field is applied between the bipolar plate substrate and a counter electrode submerged in a benign solution to remove the metal not protected by the photoresist mask. This results in the formation of the gas flow field channels on the surface of the bipolar plate.

The gas flow-field design strongly influences the fluid dynamics of the reactant gas from the inlet to the outlet and consequently plays a major role in determining the uniformity/non-uniformity of the current and temperature distributions within the fuel cell. Uniform current and temperature distributions are critical to maintaining optimal performance of the fuel cell stack as well as minimizing polarization losses and optimizing water management. The FARADAYIC ElectroEtching Process will enable the manufacturing of advanced flow channel designs that cannot be manufactured cost-effectively using more conventional machining techniques. Faraday is currently working to validate the bipolar plate manufacturing process through single cell fuel cell tests.



Sample 430 stainless steel bipolar plate with gas flow fields formed using The FARADAYIC ElectroEtching Process

Technology History

- ◆ Developed by Faraday Technology, Inc., a subsidiary of Physical Sciences Inc, in collaboration with the University of South Carolina's IUCRC Fuel Cell Center.
- ◆ Producing bipolar plates with gas flow fields for single cell fuel cell testing under automotive and stationary conditions.

Applications

Can be used in polymer electrolyte membrane fuel cell stacks intended for both stationary and automotive applications.

Capabilities

- ◆ Maintains plate flatness and plate parallelism since flow fields are formed via a non-contact process.
- ◆ Enables inexpensive manufacturing of both simple and complicated flow field designs.

Benefits

Cost Savings

Reduces the overall manufacturing cost of the bipolar plate through use of a high-volume batch process with low capital equipment and tooling costs.

Versatility

Capable of forming complex shaped flow fields in a variety of metals and alloys.

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