Development of Thermally Nitrided Metallic Bipolar Plates for Proton Exchange Membrane Fuel Cells

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Thin metallic bipolar plates offer the potential for higher power densities and better overall performance than polymer/carbon fiber and graphite composite bipolar plates currently under consideration for proton exchange membrane fuel cells (PEMFC). However, inadequate corrosion resistance in the PEMFC environment can lead to high electrical resistance from the formation of resistive surface oxides and/or contamination of the PEM with metal ions. Both of these effects significantly degrade cell performance. To solve this problem, a family of Ni/Fe-Cr base alloys, designed to form an electrically conductive and corrosion resistant Cr-nitride surface layer upon thermal nitridation, is being developed. Key issues to achieving a corrosion resistant nitride surface have been found to be related to the degree to which a continuous external Cr-nitride layer is formed, the phase makeup of the nitride layer, and the composition of the nitride, especially with regards to the selective nitridation of Cr and the incorporation of Ni or Fe into the nitride. Single-cell testing of 50cm^2 active area plates of a nitrided model Ni-50Cr alloy operated at 0.7V and 80°C for 1000 h has shown promising behavior with no increase in interfacial resistance attributable to the nitrided plates and little metal ion contamination of the polymer membrane.

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