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Enhanced low-humidity performance in a proton exchange membrane fuel cell by developing a novel hydrophilic gas diffusion layer

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Abstract

An ultrathin layer of hydrophilic titanium dioxide (TiO2) is coated on the gas diffusion layer (GDL) to enhance the performance of a proton exchange membrane fuel cell (PEMFC) at low relative humidity (RH) and high cell temperature. Both of the modified and unmodified GDLs are characterized using contact angles, and the cell performance is evaluated at various RHs and cell temperatures. It is found that the modified GDL, which contains a hydrophilic TiO2 layer between the microporous layer (MPL) and the gas diffusion-backing layer (GDBL), exhibits better self-humidification performance than a conventional GDL without the TiO2 layer. At 12% RH and 65 °C cell temperature, the current density is 1190 mA cm−2 at 0.6 V, and it maintains 95.8% of its initial performance after 50 h of continuous testing. The conventional GDL, however, exhibits 55.7% (580 mA cm−2) of its initial performance (1040 mA cm−2) within 12 h of testing. The coated hydrophilic TiO2 layer acts as a mini humidifier retaining sufficient moisture for a PEMFC to function at low humidity conditions.