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Enhancing membrane electrode assembly performance by improving the porous structure and hydrophobicity of the cathode catalyst layer

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Abstract

Enhancing membrane electrode assembly (MEA) performance is an ongoing pursuit in the drive to meet the increasing demand for fuel cell technology. In the present study, we utilize carbon nanotubes (CNTs) as porosity enhancers and polytetrafluoroethylene (PTFE) as a surface modulating agent to develop a high-performance MEA with a more porous structure and greater hydrophobicity. By systematically investigating the effects of adding CNTs and PTFE, we find that the CNTs not only increase the porosity of the cathode catalyst layer (CCL) but also boost the utilization of the platinum(Pt) catalyst by increasing the exposure of Pt active sites and lowering the charge transfer resistance, due to CNTs' superior electronic conductivity compared with carbon black. The hydrophobicity of the CCL is adjusted by adding an appropriate amount of PTFE, resulting in much better water management. The best-performing MEA contains 15 wt% CNTs and 30 wt% PTFE in the CCL. At voltages of 0.7 and 0.6 V, the discharge current densities reach 1000 and 1550 mA cm−2, respectively, with a maximum power density of 949 mW cm−2, compared to 750 and 1200 mA cm−2 and 789 mW cm−2 using a MEA without CNTs and PTFE. Our optimized MEA also exhibits significantly improved performance at low backpressure due to the increase in CCL porosity.