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Influence of Triple MPL Coated GDL on the PEFC Performance under Low and High Humidity

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The gas diffusion layers (GDLs) coated with a hydrophobic microporous layer (MPL) have been commonly used to improve the water management properties of polymer electrolyte fuel cells (PEFCs) (1). We have previously reported a hydrophilic and hydrophobic double MPL coated GDL is effective to achieve further enhancement of the PEFC performance under low humidity (2). The double MPL coated GDL is also effective to reduce flooding under high humidity, which results in higher PEFC performance compared with that for a conventional hydrophobic MPL coated GDL(3). In the present study, a novel triple MPL coated GDL, in which a hydrophilic layer was coated on a hydrophobic double MPL, was developed to enhance the PEFC performance under both low and high humidity.

PEFC performance tests were conducted under low humidity conditions of 0% RH at the cathode inlet and 60% RH at the anode inlet. PEFC performance tests were also conducted under high humidity conditions of 100% RH at the anode and cathode inlets. The cell temperature was set at 75°C. The hydrogen utilization was set at 70% and the air utilization was set at 60%. The active area of the MEA (GORE PRIMEA® 5580) was 4.2cm^2. The GDL used at the anode was a commercial carbon paper without an MPL (SGL SIGRACET® 24BA). Figure 1 shows the GDLs used at the cathode; the hydrophobic MPL, the double MPL, and the triple MPL coated GDLs. The hydrophobic MPL coated GDL consisted of a carbon paper substrate (SGL24BA) coated with an MPL of 30 mass% PTFE and carbon black. For both the double MPL and the triple MPL coated GDLs, a hydrophilic layer of 25 mass% titanium dioxide (TiO_2), 5 mass% silicone, and carbon black was coated on the hydrophobic MPL coated GDL. The PTFE content in the hydrophobic intermediate MPL of the double MPL coated GDL was varied between 10 and 40 mass%. For the triple MPL coated GDL, the PTFE content in the hydrophobic MPL in contact with the hydrophilic layer was set to 30 mass% and that in contact with the carbon paper substrate was set to either 10 or 40 mass%.

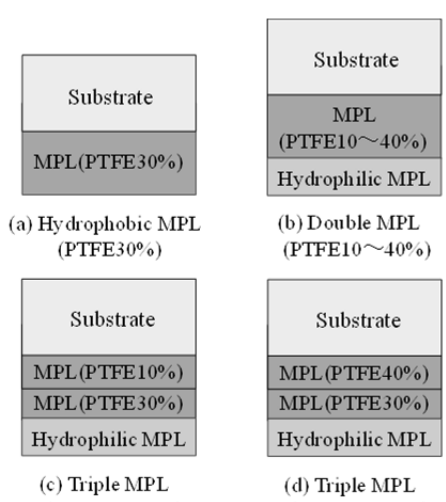

Figure 1 MPL coated GDLs used at the cathode

Figure 2 shows the influence of the double and the triple MPL coated GDLs on the PEFC performance under low humidity. For both the double MPL and the triple MPL coated GDLs, the hydrophilic layer was effective at conserving the humidity of the MEA, while the hydrophobic intermediate MPL between the hydrophilic layer and the substrate prevented the removal of water from the hydrophilic layer via dry air in the substrate. This enhanced the PEFC performance under low humidity compared with that for the hydrophobic MPL coated GDL.

Figure 3 shows the influence of the double and the triple MPL coated GDLs on the PEFC performance under high humidity. The hydrophilic layer in both the double MPL and the triple coated GDLs was effective at expelling excess water from the catalyst layer, which resulted in higher PEFC performance than that for the hydrophobic MPL coated GDL(3). For the double MPL coated GDL, the best performance was obtained with 30 mass% PTFE content in the hydrophobic intermediate MPL. The PEFC performance obtained with the triple MPL (PTFE30+40%) coated GDL was lower than that with the double MPL coated GDL. However, the triple MPL (PTFE30+10%) coated GDL, in which the hydrophobic double MPL had an appropriate gradient of hydrophobicity due to variation of the PTFE content, was effective at reducing flooding. This resulted in a much higher PEFC performance under high humidity than that for the double MPL coated GDL.

References

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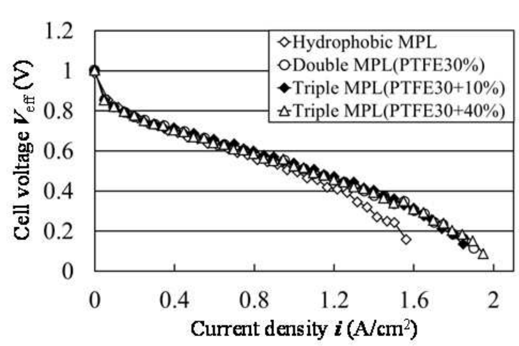

Figure 2 Influence of the double and triple MPL coated GDLs on the PEFC performance under low humidity

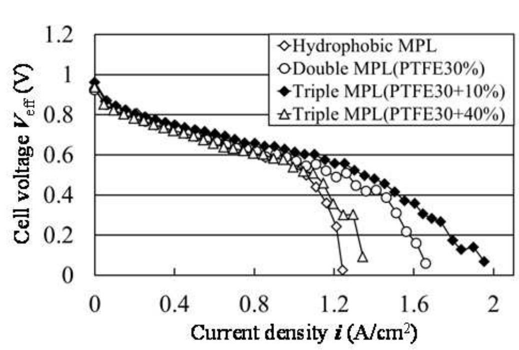

Figure 3 Influence of the double and triple MPL coated GDLs on the PEFC performance under high humidity