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Performance Improvement by Hydrophobic Diffusion-layer Installed in Cathode in DMFC

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Introduction

In practical application of direct methanol fuel cells (DMFC) which enable to use methanol directly without using any kind of reformers to generate hydrogen for mobile power sources, the improvement in power output is one of subjects to be solved. In this study the effect of hydrophobic diffusion-layer on improving output power in the DMFC are evaluated. The hydrophobic diffusion-layer, which consists of carbon (Vulcan XC-72) and Polytetrafluoroethylene (PTFE) is specially fabricated between catalyst layer and backing layer aiming to promote hydrophobic and diffusive behavior of fuel and air.

Experimental Results

Figure 1 shows the effect of thickness of hydrophobic diffusion-layer (expressed by volume) on cell voltage in case the layer is loaded in the cathode. This result shows that the power output was improved by about 20 percent under cathode hydrophobic diffusion-layer loading is over 4.0 mg/cm^2 (approximately 10 microns).

As is shown in Fig. 2, contents of PTFE mixed was examined and revealed that 50 wt percent of PTFC contents shows maximum performance improvement. Lower contents than 50 % of PTFE was not sufficient to derive the effect and higher than 50 % increased the proton resistance expressed by iR in the figure. As a result, effect of the hydrophobic diffusion-layer on performance improvement was approximately 40 percent.

Fig.3 shows the effect of hydrophobic diffusion-layer in case it was loaded in anode. In this case, any performance improvements are observed even though the amount of 4.0 mg of the layer, which exhibited the performance improvement in case it was installed in the cathode, was chosen. This means that in DMFC anode does not always requires improvement in both hydrophobicity and diffusivity. Instead only proton conductivity was damaged in case hydrophobic diffusion-layer was installed in the anode expressed by increase in iR value in the figure.

It is shown in Fig.4 that methanol crossover is reduced by around 3 to 5 percent in case the hydrophobic diffusion-layer was installed in the cathode. It can be understood from this figure that the hydrophobic diffusion-layer works to reduce methanol crossover by decreasing concentration gradient of water between anode and cathode.

Conclusion

The hydrophobic diffusion-layer, that was installed between catalyst layer and backing layer in the cathode improved output power of DMFC by around 40 percent. This effect is resulted in the reduction of methanol permeated from anode to cathode. The effects have optimum conditions both in thickness of the layer and contents of PTFE mixed in the layer.

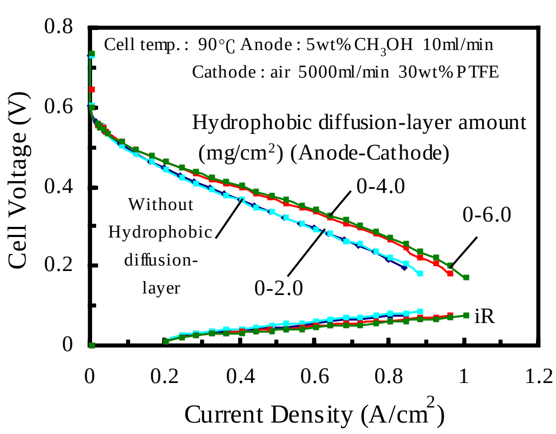

Fig.1 Effect of hydrophobic diffusion-layer on output power in case the layer was installed in the cathode

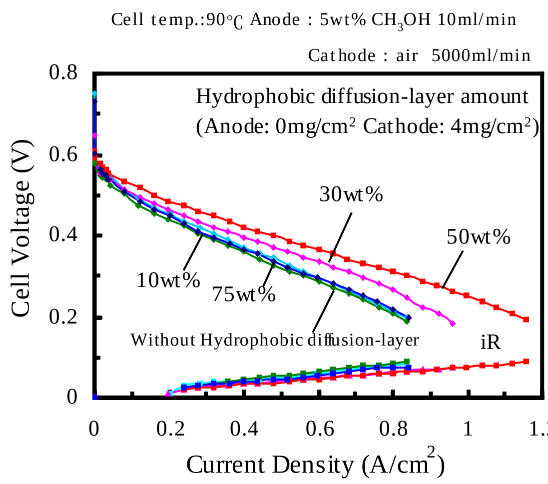

Fig.2 Effect of PTFE contents in hydrophobic diffusion-layer on performance

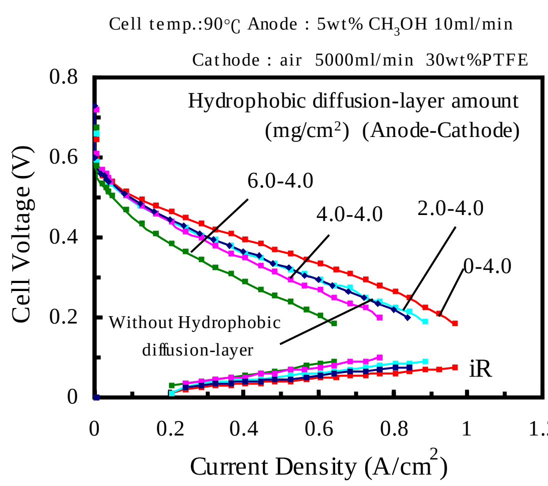

Fig.3 Effect of hydrophobic diffusion-layer in case the layer was installed in the anode

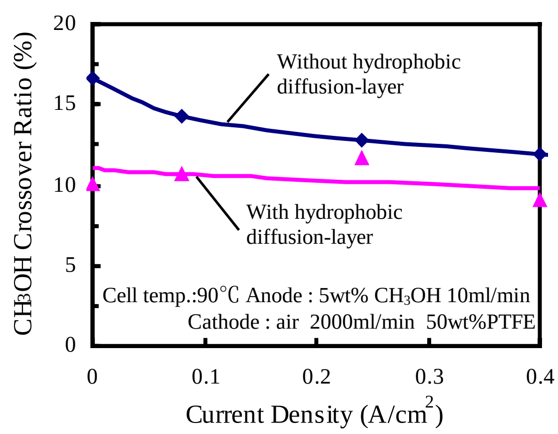

Fig.4 Effect of hydrophobic diffusion-layer on reducing methanol crossover