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Catalyst Coated Membrane (CCM) with a Microporous Layer (MPL) attached for Polymer Electrolyte Fuel Cells (PEFCs)

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We have already shown that membrane electrode assemblies (MEAs) with a hydrophilic microporous layer (MPL) work much better in a wide range of operating conditions. The hydrophilic MPL is made of carbon fiber and ionomer, and its functions are to remove excess water from the cathode catalyst layer under wet conditions and to prevent dehydration of the membrane under dry conditions. In addition to the typical MEA fabrication methods (gas diffusion electrode (GDE) and decal methods), a brand-new MEA fabrication method (M-CCM method) was conceived as shown in Fig. 1. Generally, an MPL is formed on the gas diffusion layer (GDL) substrate for water management. However, in M-CCM method, a hydrophilic MPL is attached to the cathode catalyst layer. If the CCM with an MPL attached (M-CCM) is used instead of a standard CCM using the decal method, the MEA performance will still improve even when using conventional GDLs with a hydrophobic MPL. Figure 2 compares the MEA performance of an M-CCM and a standard CCM, using commercially available hydrophobic GDLs. The M-CCM shows higher cell voltage in high current density region under a wet condition of 80°C, 100% RH. Under a dry condition of 80°C, 20% RH, M-CCM shows higher cell voltage through the whole current density region. The hydrophilic MPL is beneficial in distributing gas more effectively and keeping the membrane suitably wet. As any GDL substrate is applicable to this M-CCM, this is a unique and promising method for MEA fabrication.



Figure 1: Comparison of MEA fabrication methods.



Figure 2: Performance of M-CCM using standard GDLs

Recent Publications:

- 1. Tanuma T (2010) Innovative hydrophilic microporous layers for cathode gas diffusion media. Journal of the Electrochemical Society 157(12):B1809-B1813.
- 2. Tanuma T and S Kinoshita (2012) Impact of gas diffusion layers (GDLs) on water transport in PEFCs. Journal of the Electrochemical Society 159(2):B150-B154.
- 3. Tanuma T and S Kinoshita (2012) Impact of gas diffusion layers (GDLs) on MEA performance in PEFCs. Energy Procedia 28:12-19.
- 4. Tanuma T and S Kinoshita (2014) Impact of cathode fabrication on fuel cell performance. Journal of the Electrochemical Society 161(1):F94-F98.
- 5. Tanuma T, M Kawamoto and S Kinoshita (2017) Effect of properties of hydrophilic microporous layer (MPL) on PEFC performance. Journal of the Electrochemical Society 164(6):F499-F503.

Biography

Toshihiro Tanuma received his BS degree and MS degree in Chemistry from the University of Tokyo, Japan, in 1986 and 1988, respectively. In 1988, he joined Asahi Glass Co., Ltd., and after over 20 years of industrial experience, he received his PhD degree in Chemistry from the University of Tokyo in 2010. For the last 18 years, he has been doing research on polymer electrolyte fuel cells (PEFCs), especially on electrode design. His research interests are generally in Physical Organic Chemistry, Environmental Chemistry, and Electrochemistry.