Multi-Layered Membrane Electrode Assembly Fabrication By Electro-Spraying

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Direct energy conversion by catalyst assisted electrochemical reactions occurs on the catalyst electrodes in the membrane electrode assembly. Apparently, overall reaction seems to be simple but real reactions are very complex. Gaseous matter, proton, and electron flow through different channels and they should be present together on the catalyst surface. Polarizations concerning charge transfer and mass transfer cause overpotential. Accordingly, MEA structure needs to be optimized to reduce potential drops. In this context, effects of MEA structures on the electrochemical properties are explored. To do this, electro-spraying process is chosen for direct deposition of catalyst electrodes on proton exchange membrane. Formation of charged droplet, much finer droplet containing lower solvent, and electric field dependent particle trajectory are advantageous for direct catalyst coated membrane fabrication. Catalyst ink is composed of J&M 40 wt. % Pt/C, Nafion ionomer, and isopropyl alcohol. After depositing catalyst electrode on both sides of membrane, MEA was heat treated in different temperature and environment and then linear polarization and electrochemical impedance spectroscopy were conducted. I-V polarization behaviors are dependent on the heat treatment condition: improvements in the activation polarization and ohmic loss but deterioration of concentration polarization. It may be due to the change of pore structure according to heat treatment. Besides the heat treatment, functional layer is designed to facilitate transfer reactions. Ionomer rich thin layer is inserted between membrane and electrode while thin film having lower ionomer content than electrode is deposited between electrode and gas diffusion layer. By inserting functional layer, concentration polarization resistance can be markedly reduced.