Analysis of Catalyst Ink Compositions for Fabricating Membrane Electrode Assemblies in PEM Fuel Cells

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ABSTRACT

Determining the optimal catalyst ink formula for manufacturing membrane electrode assemblies (MEAs) in proton exchange membrane (PEM) fuel cells is important to optimizing their performance. The proper catalyst inks maintain the optimal balance of mass and ion transport in the catalyst layers. Catalyst inks are composed mainly of a carrier, Nafion solution, and a Pt/C catalyst. We investigated the optimal catalyst ink formula by varying these components during fabrication of MEAs by 20-kHz ultrasonic spraying. Various carriers (isopropyl alcohol (IPA), tetrahydrofuran (THF), and ethanol) and Nafion concentrations were investigated when using Pt/C 20% catalyst with a constant Pt loading of 0.3 mg/cm^2. The catalyst layers of the fabricated MEAs were analyzed using both in-plane and cross-sectional scanning electron microscopy (SEM) images. The thickness of the catalyst layer depended on the type of carrier, with IPA, THF, and ethanol yielding thicknesses of 28, 22, and 18 µm, respectively. Polarization curves were used to determine the fuel cell performance. MEAs fabricated with ethanol preformed better than with IPA or THF; yielding a current density of 697.02 mA/cm^2 at a cell potential of 0.6 V. The optimal Nafion concentration was 20, 25, and 30 wt% for ethanol, IPA, and THF, respectively.

Keywords: PEM fuel cell, Membrane electrode assembly, Carrier, Nafion

INTRODUCTION

Proton Exchange Membrane Fuel Cells (PEMFCs) are a promising and environmentally friendly technology. Since PEMFC products are the electricity and water generated from the electrochemical reaction between the supplied reactant gases (H_2 and O_2 or air), PEMFCs provide high efficiency and low noise. Moreover, they also operate at low temperature and pressure (Barbir, 2005).

The electrochemical reactions in PEMFCs take place in the Membrane Electrode Assembly (MEA), their most vital component. Normally, MEAs are fabricated by coating the electrode or catalyst layers on both sides of the electrolyte membrane surface. A three-region boundary, comprising the pores, ionomer,