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Optimization of gas diffusion electrode for polybenzimidazole-based high temperature proton exchange membrane fuel cell: Evaluation of polymer binders in catalyst layer

Huaneng Su, Sivakumar Pasupathi, Bernard Bladergroen, Vladimir Linkov and Bruno G. Pollet

Abstract
Gas diffusion electrodes (GDEs) prepared with various polymer binders in their catalyst layers (CLs) were investigated to optimize the performance of phosphoric acid doped polybenzimidazole (PBI)-based high temperature proton exchange membrane fuel cells (HT-PEMFCs). The properties of these binders in the CLs were evaluated by structure characterization, electrochemical analysis, single cell polarization and durability test. The results showed that polytetrafluoroethylene (PTFE) and polyvinylidene difluoride (PVDF) are more attractive as CL binders than conventional PBI or Nafion binder. At ambient pressure and 160 ^{o} C, the maximum power density can reach w 0.61 W cm^{-2} (PTFE GDE), and the current density at 0.6 V is up to ca. 0.52 A cm^{-2} (PVDF GDE), with H_2/air and a platinum loading of 0.5 mg cm^{-2} on these electrodes. Also, both GDEs showed good stability for fuel cell operation in a short term durability test.

1. Introduction

Polybenzimidazole (PBI) based high temperature proton exchange membrane fuel cells (HT-PEMFCs) have attracted more and more attention in recent years due to their advantages over low temperature PEMFCs based on perfluorosulphonic acid polymer electrolytes (e.g. Nafion) [1]. With the capability of operating at 120e200 ^{o} C, HT-PEMFCs are very promising alternative power generation devices due to their (1) faster electrode kinetics, (2) low dependency on cooling system, (3) high amount of reusable heat energy, (4) high tolerance to pollutants (e.g. CO), and (5) high practicability in mixed hydrogen systems [2e4]. They are commonly used in stationary fuel cell systems to increase tolerance to reforming gas and minimize the purification requirements for a reforming system. Also, high temperature operation can eliminate the need for a humidification unit, which can be very beneficial for fuel cell vehicle applications [5]. However, the sluggish kinetics of the oxygen reduction reaction (ORR) and

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