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Short communication

Novel method for preparation of PEMFC electrodes by the electrospray technique

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Abstract

A novel method based on the electrospray technique has been developed for the preparation of electrodes for proton exchange membrane fuel cells (PEMFC). The material obtained was characterized by different techniques, which showed both morphological and structural improvements that contribute to a better catalyst utilization compared to conventional methods. These facts were corroborated after manufacturing several membrane electrode assemblies (MEAs) with electrodes prepared by three different methods. MEAs obtained by means of the electrospray technique exhibited three times higher power density than those prepared by the impregnation method ones and eight times higher than MEAs made with electrodes prepared by the spray technique with platinum loadings of 0.5 mg cm^{-2}. Moreover, the power density obtained was twice better than a commercial E-TEK. This technique can be scaled up and becomes a volume production method using a low-cost process.

Keywords: PEMFC; MEA; Electrodes; Electrospraying

1. Introduction

One of the main requirements for fuel cell commercialisation is to reduce the cost of the materials used. Due to the fact that proton exchange membrane fuel cells (PEMFC) need precious metals as electrocatalyst, generally platinum and its alloys, decreasing the amount of active metal without sacrificing the performance is mandatory. For this purpose, it is important to increase the reaction sites in the catalytic layer, which are in direct contact with the membrane and the gas diffusion layer to form the membrane-electrode assembly (MEA) [1]. Moreover, in addition to the catalyst loading, there are a number of catalyst layer properties that have to be optimised to achieve a high utilization of the catalyst material: i.e. reactant diffusivity, ionic and electrical conductivities and the level of hidrophobicity, which have to be carefully balanced [2].

At the moment, there are two modes for manufacturing MEAs [3] that consist in the application of the catalyst layer to either the gas diffusion layer or the membrane. The hot-pressing procedure is then used to add the membrane or the gas diffusion layer, respectively. The first option has the advantage of preserving the membrane of chemical attacks of the solvents present in catalytic inks. It allows applying later steam or boiling water treatments, which increase the number of active sites or regions in the catalyst layers [4], or adding pore formers to the catalytic layer to create the sufficient porosity for mass transportation [5].

In order to obtain a suitable catalyst layer structure, several methods to prepare electrodes have been developed. Typical methods of manufacturing like casting [6], painting [7,8], spreading [9], spray [10–12] or catalyst powder deposition [13] do not allow a high dispersion of the catalyst and, as a consequence, the utilization of the platinum is low. So, several alternatives have been proposed to decrease the catalyst loading with adequate performance. In this way, common vacuum deposition methods that include chemical vapour

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