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Implementation of DEIS for reliable fault monitoring and detection in PEMFC single cells and stacks

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Abstract

Dynamic Electrochemical Impedance Spectroscopy (DEIS) was presented as novel method for diagnostic and monitoring of PEMFC stack and single cells operation. Impedance characteristics were obtained simultaneously with current - voltage characteristics for stack and each individual cell. Impedance measurements were performed in galvanodynamic mode. It allowed to compare performance of each cell and identification of faulty cell operation for activation, ohmic and mass transfer losses regions. The biggest difference in impedance value between healthy and faulty cell was registered for mass transfer losses region. The authors discussed the statistical selection of an equivalent circuit based on the course of χ^2 value in the function of current.

Keywords: PEM Fuel Cell; Performance; Diagnostics; Impedance; Equivalent Circuit

1. Introduction

Proton Exchange Membrane Fuel Cells (PEMFC) are already used in many areas of our lives. They are successfully applied as energy sources in stationary [1,2], mobile [3,4] and transport applications [5,6]. According to the assumptions specified in the report "Electrical Vehicles in Europe" of the European Environment Agency from 2016, it is planned to decrease share of cars with combustion engine by half in city transport by 2030 and to completely withdraw combustion engine cars from cities by 2050. These actions are aimed to reduce emission of greenhouse gas by 85-90% to 2050. According to the U.S. Department of Energy, sale of fuel cell cars increased 7 times during one year (February 2016 - February 2017). However, mass use of fuel cell stacks is still limited because of the following issues: lifetime, cost and efficiency of energy conversion. Those issues depend on many

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