measuring and research laboratory, and other required and/or related facilities.
There is some money available to finance this project, and we are looking for- and expecting contributions from local and from international institutions.

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EXPERIMENTAL DATA AND MATHEMATICAL MODEL OF A 500 We PEMFC FUEL CELL STACK COMBINED TO A DC-DC STEP-UP CONVERTER WITH ENHANCED POWER OUTPUT

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Abstract

This work presents experimental results of a mathematical model combining a 500 We PEMFC fuel cell stack (MCC500) to a DC-DC step-up converter with enhanced power output. The MCC500 was developed at IPEN (Nuclear and Energy Research Institute) and Electrocell®, with Brazilian technology [1], [2]. The DC-DC stepup converter is able to receive the electrical potential produced (generated) at MCC500 and make it available on relatively stable potential for the load use, and thereby improving the conversion efficiency, especially when demand is high and the potentials generated are small. Mathematical developments and modeling have also been performed, relied on experimental data collected at IPEN laboratory [3]. The first step was to prepare an electrical system, pre-design for the proposed model, which included MCC500 parameters: membrane ohmic resistance (R1), activation resistance (R2), electric double layer capacitance (C), open circuit potential (E); as well as DC-DC step-up converter parameters, inductor (L) and transistor switching frequency (fch). Polarization curves were built using experimental data, which associated with the pre-design electrical system, resulted in the desirable MCC500

parameters [4], [5], [6], [7], [8], [9], and [10].
Using the obtained parameters and a linear differential equations system and some mathematical manipulations, an electrical system data was determined, which includes parameters from another module (SR-12, Avista Labs). In this way the presented model was parameterized [10], [11].
The simulation using Matlab7® computational program was shown to be very effective in determining system behavior and allowing the evaluation of either the output potential elevation or the computational disturbance stability. The system showed to be very stable both by the characteristic equation Root Locus Analysis and by the Nyquist Mapping Theorem [10], [12].
The contribution given by the developed model was very important to generated useful potential for practical purposes, increasing the overall electrical efficiency, using the MCC500 system.

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leads to a rapid oxidation of the Si nanocrystallites (nc-Si). The diffusion of oxygen (substituted to Si–H in immersion process) in the inner of nc-Si modify the crystallite size which explain the instability of the luminescence under temperature variation. In the case of PS/Co sample, two different mechanisms were proposed; one is the desorption of Si-$H_{x(x=2,3)}$ with the formation of cobalt oxide for annealing temperature less than 450°C which cause the increasing of PL intensity and the stability of PL energy, the other mechanism is the transformation of the porous silicon to silica at high temperatures (> 500°C) [6] which leads to the decreasing of the PL intensity and the blue shift of the PL curve.

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DEFC SCALING UP SIMULATIONS

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Keywords: DEFC, scale up, simulation, CFD

Abstract

The scaling up process in fuel cells is one of the main steps to obtain a commercial fuel cell. The use of computational simulations for many operational conditions allows the optimization of these conditions and in this way, it can help to determine, for example, the best temperature, humidity and flow rates, required to achieve minimal performance losses and to achieve high efficiencies[1, 2].

The results of numerical simulations for the scaling up[3] from 5 cm^2 to 144 cm^2 geometric area of a DEFC (Direct Ethanol Fuel Cell) are presented in this work. The CFD simulations were performed using the COMSOL software and 5 cm^2 experimental data obtained at the Fuel Cell and Hydrogen Laboratories at IPEN-Institute for Nuclear and Energy Research[4].

The operational parameters implemented in the simulations were: range of temperature: 80°C – 110°C, ethanol flux: 2 mL min^{-1}, permeability of diffusion layer: 1.0 10^{-13} m^2, and oxygen as cathode gas.

The diffusion layer physics were implemented in the Brinkman Equations Chemical Engineering COMSOL Module. The z-velocity was the concerned parameter, since this gas velocity represents the velocity that the gas permeates the porous layer in the MEA (Membrane Electrode Assembly).

The considerations related with the 5 cm^2 fuel cell were: steady state analysis, 53,266 tetrahedral elements mesh, 295,505 degrees of freedom and SPOOLES direct linear solver. With relation to the 144 cm^2, the parameters were: steady state analysis, 81,118 tetrahedral elements mesh, 459,331 degrees of freedom and the same linear direct solver.

There are 16-parallel and 4-serpentine channels composing the 5 cm^2 flow channel plate while for the 144 cm^2 there are 60-parallel and 5-serpentine channels.

It was observed that for the 5 cm^2 fuel cell, v_z = 1.56 10^{-5} m s^{-1} and p = 6.37 103 μN, compared to the values for the 144 cm^2, v_z = 9.82 10^{-10} m s^{-1} and p = 7.25 μN.

These results were obtained under the same boundary conditions: 80°C, input flux of 2 mL min^{-1} of ethanol vapor and zero output pressure in the porous layer.

It was noticed a non-linear behavior of the simulated results in relation to the increase of the proposed scales. With this data, it was expected a better performance related to the 5 cm^2 fuel cell, indicating the necessity of optimization of the input flux, the permeability of the porous layer and the operation temperature, to achieve higher active area fuel cells.

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