Experimental dataset of electrochemical efficiency of a Direct Borohydride Fuel Cell (DBFC) with Pd/C, Pt/C and Pd decorated Ni–Co/rGO anode catalysts

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Abstract

Dataset includes Direct Borohydride Fuel Cell (DBFC) impedance and polarization test in anode with Pd/C, Pt/C and Pd decorated Ni–Co/rGO catalysts. In fact, different concentration of Sodium Borohydride (SBH), applied voltages and various anode catalysts loading with explanation of experimental details of electrochemical analysis are considered in data. Voltage, power density and resistance of DBFC change as a function of weight percent of SBH (%), applied voltage and amount of anode catalyst loading that are evaluated by polarization and impedance curves with using appropriate equivalent circuit of fuel cell. Can be stated that interpretation of electrochemical behavior changes by the data of related cell is inevitable, which can be useful in simulation, power source investigation and depth analysis in DB fuel cell researches.

Highlights:
- Experimental data of DBFC with detail of single cell structure and test conditions.
- Electrochemical analysis present valuable data of DBFC efficiency for simulation and learning of DBFCs behavior.
- Graphical outputs of data for better understanding and comparison.

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1- Data Introduction
Direct Borohydride fuel cell is a subset of alkaline fuel cells. Sodium Borohydride (SBH) solution can be counted as a source of hydrogen fuel and air/oxygen is an oxidant in DBFCs. In fact, hydrogen regenerated by catalytic decomposition reaction of Borohydride [1,2].

Reported dataset presents electrochemical efficiency of DBFC single cell by providing structural details of cell in various weight percent of SBH, different catalysts (Pd/C, Pt/C and Pd decorated Ni–Co/rGO) by changing the loading rate of each of them (mg.cm\(^{-2}\)) in various applied voltages in the presence of both oxidants (air/oxygen).

Electrochemical analysis includes Polarization and Electrochemical Impedance Spectroscopy (EIS) what both of those are the most important electrochemical tests in fuel cell researches. Polarization analysis provide significant information related to cell efficiency such as power density (mW.cm\(^{-2}\)), voltage (V) and current density (mA.cm\(^{-2}\)). Impedance spectroscopy that counted as the most popular analysis techniques in electrochemistry and electrical engineering, presents valuable information about structure of material, resistance of cell, constant phase element and others that helpful to explain how cell efficiency change in different ways. Equivalent circuit of cell structure is necessary for extraction the parameters from impedance plots [2,3].

Therefore, by mention of experimental details of cell structure such as anode, cathode, anode and cathode support, electrolyte conditions and test properties can be claimed that the dataset provide remarkable and essential information about DBFC performance for researchers who want to use empirical data for study on experimental fuel cell setup, simulation or machine learning analysis to build an analytical and a mathematical model based on resulted data.

Dataset is reported in ECSIM organization GitHub account [4]. ECSIM organizarion is a research team that investigate on power sources by experimental equipment to provide valid usable data [5] and make useful software for improvement of research and development in power sources. This dataset is licensed under a Creative Commons Attribution 4.0 International License. The images or other third party material in this article are included in the article’s Creative Commons license, unless indicated otherwise in the credit line; if the material is not included under the Creative Commons license, users will need to obtain permission from the license holder to reproduce the material [6].

2- Report Data
2-1- Cell Structure
Electrodes structures include Pd/C (4.4, 8.8, 13.4, 17.7 mg.cm\(^{-2}\)), Pt-C 20wt. % and Pd decorated Ni–Co/rGO (4.4, 8.8, 13.4, 17.7 mg.cm\(^{-2}\)) as anode catalyst, Nickel foam as anode support, HypermecTM K14 (5 mg.cm\(^{-2}\)) as cathode catalyst, Carbon cloth with surface area 4.5 cm\(^{2}\) as cathode support.
Electrolyte is 2M KOH and different concentration of Sodium Borohydride (SBH) (1, 3, 5, 8 wt. % SBH that in some tests 0.05 and 0.5 wt. % are considered too).

All tests were analyzed in room temperature. Polarization study was performed in different Sodium Borohydride concentration (1, 3, 5, 8 wt. % SBH) and electrochemical impedance spectroscopy was studied at operating DC voltages of 0.3V, 0.5V, 0.7V.

2-2- Pd/C catalyst in DBFC
Data of Pd/C catalyst in Direct Borohydride fuel cell include Nyquest spectra of various Pd/C loading in DBFC fueled by solution containing 1, 3, 5, and 8 wt. % of SBH at 0.3V, 0.5V and 0.7V, Nyquest spectra of 8.8 and 17.7 (mg.cm⁻²) Pd/C loading in DBFC fueled by solution containing 5 wt. % of SBH and O2 as oxidant at 0.3V, 0.5V and 0.7V, cell polarization curves of various Pd/C loading in DBFCs fueled by solution containing different wt. % of SBH, Cell polarization curves of 8.8 and 17.7 (mg.cm⁻²) Pd/C loading in DBFCs fueled by solution containing 5 wt. % of SBH with Air as oxidant and Cell polarization curves of 8.8 and 17.7 (mg.cm⁻²) Pd/C loading in DBFCs fueled by solution containing 5 wt. % of SBH with O2 as oxidant.

Figure 2-1 and 2-2 represent examples on Nuquest plot and polarization curves at specific Pd/C loading and SBH%, respectively.

2-3- Pt/C catalyst in DBFC
Nyquest spectra of Pt/C anode DBFC fueled by solution containing 1, 3, 5, and 8 wt. % of SBH at 0.3V, 0.5V and 0.7V was analyzed and reported. Figure 2-3 shows a sample of Nyquest plot at various applied voltages and SBH% by the Pt/C catalyst.

2-4- Pd decorated Ni–Co/rGO catalyst in DBFC
Data related to Nyquest spectra of various Pd decorated Ni–Co/rGO anode catalyst loading in DBFC fueled by solution containing 1, 3, 5, and 8 wt. % of SBH at 0.3V, 0.5V and 0.7V was presented and figure 2-4 shows an example of Nyquest plot at specific Pd decorated Ni–Co/rGO loading and various SBH% and applied voltages.
Figure 2-1: Nyquest spectra of 8.8 mg.cm\(^2\) Pd/C in DBFC fueled with solution containing 1, 3, 5, and 8 wt. % of SBH at 0.5V.

Figure 2-2: Cell polarization curves of 4.4 mg.cm\(^2\) Pd/C in DBFCs fueled by solution containing 1, 3, 5, and 8 wt. % of SBH.
Figure 2-3: Nyquest spectra of Pt/C in DBFC fueled with 3 wt. % SBH at 0.3V, 0.5V and 0.7V.

Figure 2-4: Nyquest spectra of Pd decorated Ni–Co/rGO in DBFC fueled with solution containing 1, 3, 5, and 8 wt. % of SBH at 0.3V.
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