Metrohm Autolab

Application Area: Fuel Cells

i/V Characterization of a Fuel Cell Stack
DC Measurements at High Current Densities

Keywords

Fuel cell stack; PEMFC; Electronic load; High current measurements

Introduction

The operational behavior of a fuel cell stack is usually evaluated by determining the polarization and power density curves of the cell. These curves provide a quick characterization of the stack performance and an assessment of its optimal operating conditions (temperature, humidity, electrocatalysts, and ion-exchange membrane).

Most fuel cell stacks operate at currents higher than 10 A, therefore, an electronic load can be used in combination with Autolab PGSTATs to replicate the desired experiment conditions. While the electronic load draws the current from the cell, the Autolab PGSTAT measures the electromotive force of the cell.

The voltage of a fuel cell stack is equal to the sum of the individual cell voltages in the stack, and can reach values higher than 10 V, which is outside of the measurable range of most potentiostats. For the Autolab PGSTAT302N, an optional Voltage Multiplier is available, which allows measurements of stack potential up to 100 V (Figure 1).

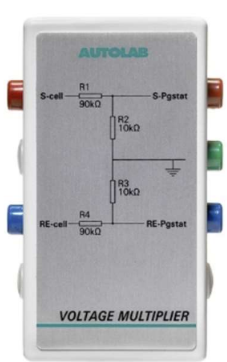

Figure 1 - The Voltage Multiplier

Choice of the electronic load

For the experiments presented in this application note, four Chroma series 63030 electronic loads were used, in a parallel configuration. Each load module is capable of drawing a current of 60 A, which means that a total of 240 A discharge current can be achieved. The maximum voltage was 60 V. One of the loads was the controller of the other three other loads.

The experiments described can also be performed in combination with many other commercially available loads.

Connections between Autolab and Load

The connection between the Autolab PGSTAT302N and the electronic load modules requires the Autolab Dynamic Load (Dynload) Interface (Figure 2).

Figure 2 - The Dynamic Load Interface

Experimental conditions

The electronic loads used in these experiments have a combined maximum current of 240 A, and a voltage range of 0 V – 60 V. Measurements were performed on 14 Polymer Electrolyte Membrane Fuel Cell (PEMFC) stack with dispersed Pt as a catalyst on both the anode and the cathode. The fuel cell was operated on humidified H_2/Air at 50 °C. Each fuel cell has a surface area of 200 cm^2.

The polarization curves were obtained using an Autolab PGSTAT302N in combination with the NOVA software. The electronic load was used to draw predefined currents from the fuel cell stack. The electromotive force of the stack was measured using the differential electrometer of the PGSTAT302N in combination with the voltage divider. The measured value was automatically corrected for the division in the software.

The electronic load was operated in Constant Current (CC) while the Autolab PGSTAT302N was operated in potentiostatic mode. The procedure used in the NOVA software was designed to measure the potential of the stack during 30 seconds, using an interval time of 10 ms, for each value of the current drawn from the stack. The value of the discharge current was controlled directly by the software. The values varied between 0 A and 170 A.

Experimental results

The potential was measured continuously, while increasingly large current values, up to 170 A, were drawn from the fuel cell stack.

Figure 3 shows the discharge current (A) and measured potential (B) profiles during time.

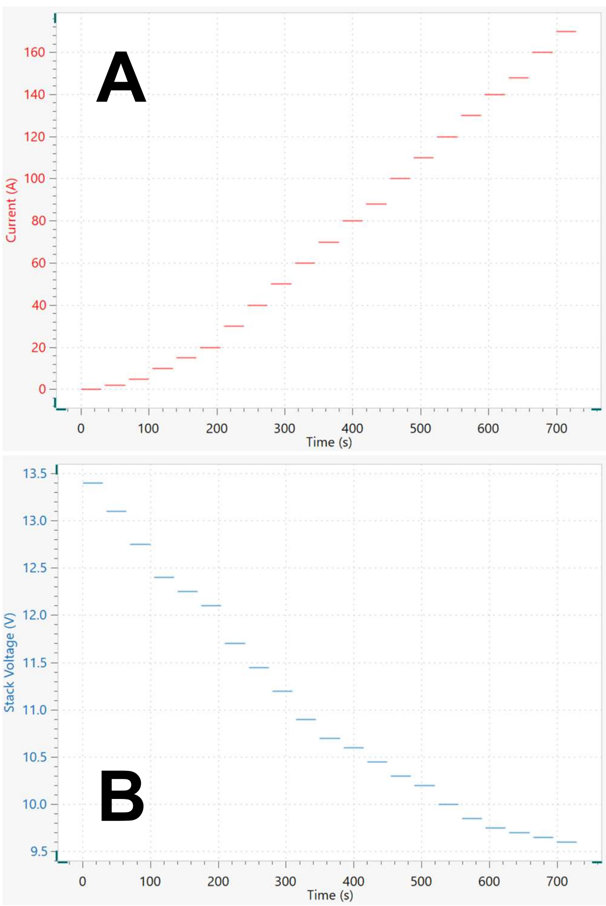

Figure 3 – Discharge current (A) and measured potential (B) profiles.

The total measurement time was about 700 seconds. After the measurements, the NOVA software was used to build the complete polarization curve and the power density curve ($P = i \cdot E$), using the measured potential values and the applied discharge current values.

Figure 4 shows the polarization curve obtained for the 14 cell fuel stack.

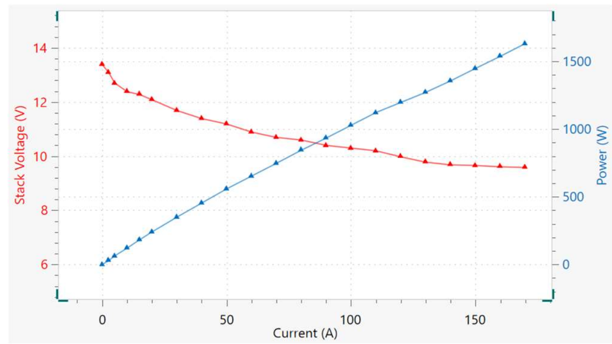

Figure 4 – Polarization curve (red) and power density curve (blue), obtained from the experimental current and potential values.

Using this experimental setup, it was possible to compare the performance of different fuel cell assemblies. Figure 5 shows a comparison of two different stacks, operating in the same experimental conditions.

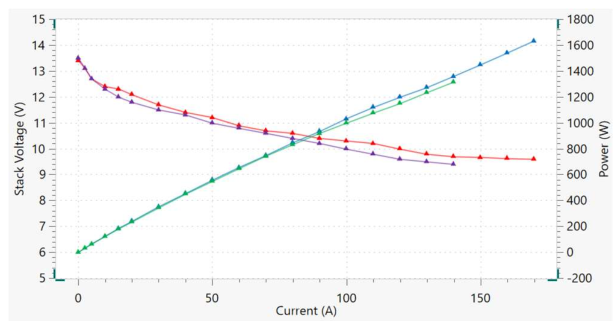

Figure 5 – Direct comparison of the fuel cell stack performance (Stack 1, red I/V curve, blue power density curve vs. Stack 2, purple I/V curve, green power density curve).

Conclusions

The measurements presented in this application note demonstrate the combination of the Autolab PGSTAT302N with a high-power electronic load. The full polarization curve of a large stack could be measured using this experimental setup.

The electronic load, in combination with the PGSTAT302N, was used to sink currents higher than 2 A while the voltage divider allowed the PGSTAT302N to measure stack potentials greater than 10 V.

Date

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For more information

Additional information about this application note and the associated NOVA software procedure is available from your local **Metrohm distributor**. Additional instrument specification information can be found at **www.metrohm.com/electrochemistry**.