Application Note AN-FC-003

燃料池第 3 部分--利用 EIS 行表征

In the previous application notes it was shown that fuel cells are promising power sources as they offer highly efficient and environmentally friendly solution for alternative energy. In recent years considerable research is being done to provide a better understanding of the factors that affect the performance of a fuel cell.

In this application note the use of Electrochemical Impedance Spectroscopy (EIS) for the characterisation of PEM fuel will be demonstrated. It will be shown that EIS is a powerful diagnostic tool for the determination of the following factors that can influence the performance of a PEM fuel cell:

- Electrode composition and structure
- Membrane characteristics
- Operating parameters such as, cell temperature, humidification, gas composition and pressure

The main advantage of EIS as a diagnostic tool is its capacity to resolve in the frequency domain the individual contributions of the various factors that determine the overall PEM fuel cell power losses:

- Kinetic
- Ohmic
- Mass transport

The experiments were done on the fuel cell test station at Electrochemistry group in the Department of Chemistry at the North Eastern University in Boston, USA.

The experiments were conducted using an AUTOLAB PGSTAT302N controlled by NOVA software. The EIS measurements were performed using the FRA32 module controlled by NOVA software. The 10 A current booster unit was used as the load.

The fuel cell used for the experiments was a single cell with a geometric surface area of 5 cm^2 comprising a Nafion polymer electrolyte membrane. The electrodes consisted of a thin-film catalyst layer. The electrodes were supplied with pure hydrogen or hydrogen with small quantity of CO at the anode and with hydrogen (for reference measurements), air or oxygen at the cathode.

The EIS experiments were done under potentiostatic control. For the cell with hydrogen at the cathode, the EIS experiments were done at OCP (0.0 V). For experiments with air and oxygen the experiments were done at the applied potential of 0.8 V, 0.6 V and 0.4 V. A frequency range of 10 kHz – 0.01 Hz was used. The amplitude of the AC perturbation was set to 10 mV.

EXPERIMENTAL RESULTS

In **Figure 1** the results of the EIS experiment with H_2 at the cathode are compared with those with O_2 and air at the cathode.
When only hydrogen is at both the anode and cathode side of the electrode there is no reduction reaction that takes place at the cathode and one measures the ohmic losses across the membrane. When the hydrogen is replaced by oxygen at the cathode then the reduction of oxygen at the cathode occurs. The charge transfer resistance of the reduction reaction can therefore be measured. When oxygen is replaced by air at the cathode then the effect of mass transport can be seen. Oxygen has to diffuse through nitrogen present in air to reach the cathode surface, this result in an increase in the polarisation resistance due to the diffusion resistance as seen in **Figure 1**.

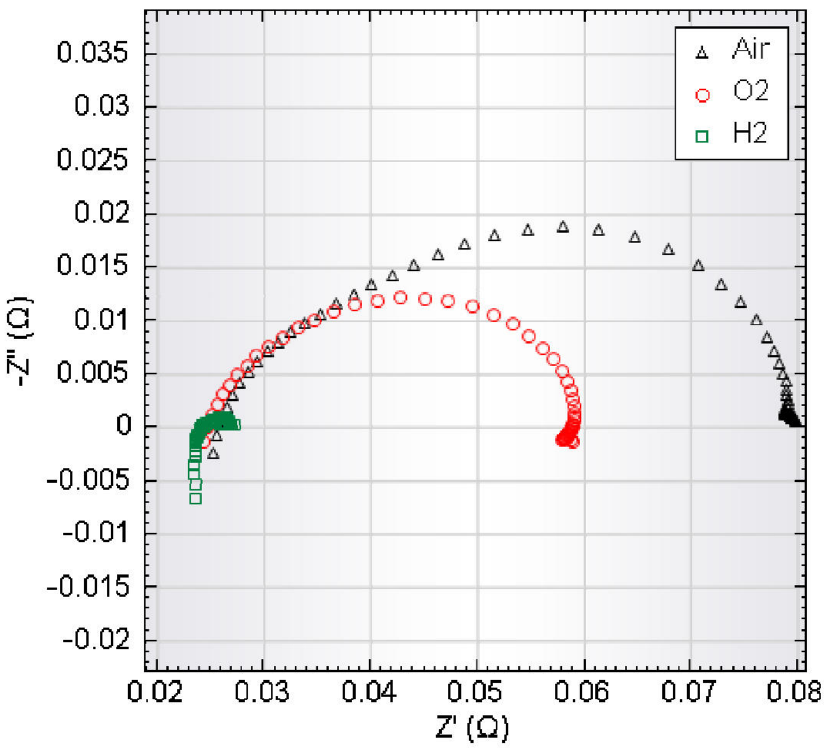

Figure 1. Results of EIS experiment on a PEM fuel cell with H2, O2 and air at the cathode

In **Figure 2** the effect of the poisoning of the catalyst by CO can be seen. With the introduction of CO in air on the anode side the charge transfer resistance for the oxidation of hydrogen increases due to the poisoning of the catalyst.

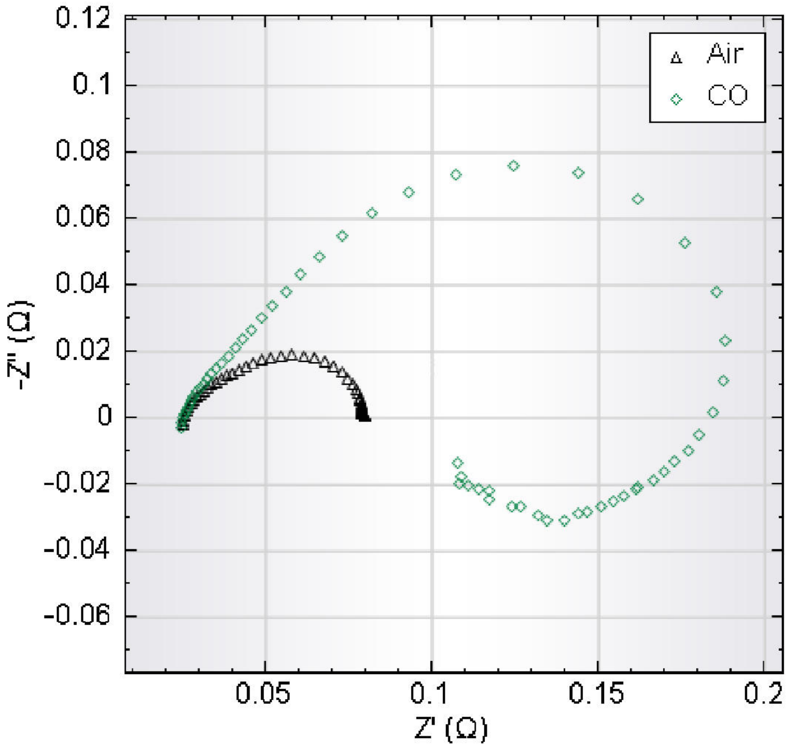

Figure 2. Results of EIS experiments on a PEM fuel cell with air and CO at the anode

With the introduction of CO in air on the anode side the charge transfer resistance for the oxidation of hydrogen increases due to the poisoning of the catalyst.

REFERENCES

1. M. Ciureanu, R. Roberge, J. Phys. Chem. B, 2001, 105, 3531-3539

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EXPERIMENTAL CONDITIONS

Autolab PGSTAT204

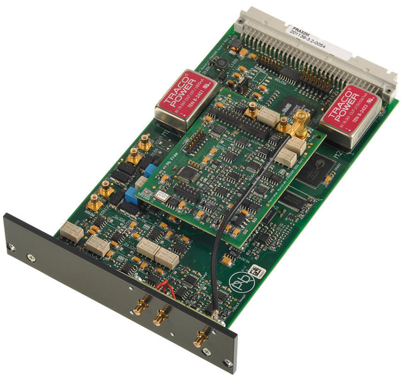
PGSTAT204 合了小巧格和模化。器包括基本恒位/恒流,其从 20 V,最大流 400 mA 或 10 A,与 BOOSTER10A 合使用。此恒位可随用附加模行展,例如 FRA32M 化学阻抗(EIS)模。

PGSTAT204 是一款惠的器,可置于室的任何位置。具有模和数字入/出,可控制 Autolab 附件和外部。PGSTAT204 包括内置模分器。与高性能的 NOVA 件用,可用于大多数准化学技。

Autolab PGSTAT302N

恒位/恒流,具有 30 V 从, 1 MHz,可与我的 FRA32M 模用,化学阻抗而。

PGSTAT302N 是流行的 PGSTAT30 的后款型。最大流 2 A,借助 BOOSTER20A 流范可展至 20 A,当流范 10 nA 流分辨率 30 fA。



FRA32M 提供了用于量阻抗的工具,与 Autolab 用可量化学阻抗。模允在 10 μHz 至 32 MHz 的率范中同行恒位和恒流阻抗量(与 Autolab PGSTAT 用限 1 MHz)。除了的 EIS 化学阻抗之外,NOVA 件允用其它外部信号,如旋的速或光源率,以量-流体或光制阻抗。FRA32M 模有功能大的匹配和真件,可分析阻抗数据。

Booster 10A

Booster10A 模可将 PGSTAT100N, PGSTAT128N, PGSTAT302N, PGSTAT204 或 M204 的最大流增至 10 安培。与 Booster10A 用系的从 20 V。

凭借其快速的,合 FRA32M 模 Autolab Booster10A 可化燃料池、蓄池和超容器的化学阻抗性能。booster 既可用于主性池也可用于被性池。Booster10A 可用于量超容器的充和放特性、燃料池的性能或大面上的DC或AC量。

NOVA 是通 USB 接口控制所有 Autolab 器的件包。由化学家化学而,集成了超二十余年的用体和最新的 .NET 件技,NOVA 使的 Autolab 恒位/恒流有更性能和活性。

NOVA 提供了以下的独特功能:

- 功能大且活的程序器
- 重要数据一目了然
- 大的数据分析和工具
- 集成化控制外器,如万通 LQH 液体理

下最新版本的 NOVA