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Gas concentration impedance in an SOFC plug flow setup

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A significant part of the resistance in today's state-of-the-art Solid Oxide Fuel Cells (SOFCs) is attributed to gas concentration changes at the active sites of the electrodes. The change in the gas concentrations occurs when reactants in the gas are electrochemically converted into products as current is passed through the cell. Here we present a model of the gas concentration impedance of an SOFC in a plug flow setup and use it as a diagnostic tool on experimental findings. The gas concentration impedance depends on the current distribution in the electrode. A non-uniform distribution of the resistance in the electrode will consequently affect the gas concentration impedance.

An anode supported SOFC was tested as a steam electrolysis cell at 850 °C. The current density was -0.25 A/cm^2 and the gas composition to the Ni/YSZ electrode was 99 vol% H_2O and 1 vol% H_2 at a rate of 12 l/h. O_2 was purged to the LSM/YSZ electrode at a rate of 20 l/h. The cell performance decreased significantly during the electrolysis operation resulting in a significant increase in the cell impedance. (Figure 1) The time delay after onset of the electrolysis operation where the spectra were recorded is presented in Table 1.

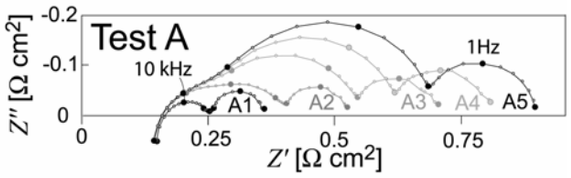

Figure 1. Impedance spectra recorded on an SOFC during steam electrolysis operation.

Table 1. Time delay after onset of electrolysis operation.

Spectrum	A1	A2	A3	A4	A5
[hours]	10	88	131	157	229

The low frequency arc in the impedance spectra is identified as the gas conversion impedance. Note how this arc increases during the electrolysis operation. We relate the increase of the arc to a redistribution of the current through the electrode, due to a build-up of a non-uniform distribution of the resistance in the electrode.