

Application 2055



Investigation of liquid water accumulation during oscillations in a PEFC with SINQ

Daniel Garcia Sánchez

(DLR) German Aerospace Center, Stuttgart, Germany

Project objectives:

It was found that PEM fuel cell operated under low cathode gas humidification and full anode gas humidification exhibit oscillatory performance fluctuations. Hereby the cell performance periodically changes between a high level and a low level. The performance at the high level is in good accordance with the performance of a well humidified cell (i.e. full humidification of cathode and anode gas streams). The cell performance at the low level is determined by the amount of humidification of the anode gas. The oscillatory behavior of the cell performance is coupled with an oscillatory behavior of the current density distribution inside the cell. At a high cell performance the current distribution is fairly homogeneous, whereas at low cell performance the current distribution is very inhomogeneous exhibiting a region where the current density is rather high and a second region where the current density is very low or zero.

In order to be able to explain and describe the mentioned cell behavior and its basic cause in more details special project objectives are

- To investigate the liquid water distribution inside a PEM fuel cell operated under low cathode humidification and full anode humidification;
- To establish a correlation between the liquid water distribution and the current density distribution inside the cell;
- To clarify whether or not the oscillating performance behavior is caused by a local accumulation of liquid water in the flow field channels of the cell;
- To find out whether the bulk conductivity of the membrane or the interfacial conductivity between membrane and catalyst layer is changing in some cell regions.

Project duration:

The duration of the project has been estimated to be 4 working days, i.e. one day for preparing the facilities and three days for testing.

Required in-situ measurement techniques:

- Neutrons imagine technique using SINQ, imaging stations NEUTRA and ICON to investigate the liquid water distribution;
- Current density measuring technique using DLR segmented bipolar plates.

Experimental conditions:

Cell design:

- Flow field with a single meander gas channel
- Active area: 25cm²
- Material of cell plates: Aluminum with a gold coating.

Operation conditions:

- Cell temperature: 80°C, 70°C
- Pressure: 1.5bar
- Relative humidity: cathode approximately 5–70% and anode approximately 75–135%.
- Counter flow (Air/H₂)
- Flow range: Anode approximately 50-500 ml/min cathode approximately 100-100 ml/min