



	Experiment title: Effects of alloy formation on the stability and degradation of Pt based PEM fuel cell cathode catalysts	Experiment number:
Beamline: ID24	Date of experiment: from: 23 July 2008 to: 30 July 2008	Date of report: 1 March 2009
Shifts: 18	Local contact(s): Mark Newton	<i>Received at ESRF:</i>
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Report:

The aim of the experiment were to conduct an initial investigation of the time resolved XAS of PEM fuel cell cathode catalysts, Pt/C and PtCr/C, in a working PEM fuel cell. To accomplish this aim we:

1. Established the experimental protocols for use of the miniature PEM fuel cell (shown in figure 1) on ID24, which involved synchronising the electrochemical and spectroscopic measurements as well as satisfying the safety aspects of such an experiment. Operation of the fuel cell requires use of pure H₂ and O₂, separated by a thin (< 50 µm) polymer membrane.
2. Conducted time resolved XAS measurements, focussing primarily on the XANES region, following a step-change of the applied potential, which corresponds to a change in the load (current) demanded of the fuel cell. Experiments were conducted in two modes, half-cell and full-cell. For the half-cell measurements H₂ is fed to the anode, which also serves as the reference electrode, and N₂ to the cathode. For the full-cell measurements H₂ is fed to the anode and O₂ to the cathode. An extensive set of half-cell measurements were completed for a Pt/C cathode catalyst and a limited number of half-cell experiments for two PtCr/C cathode catalyst electrodes. The time resolution of the measurements was 10 ms, which enabled observation of the structural changes that occur upon going from a fully reduced to a fully oxidised state of the cathode catalyst. The depth of change (oxidation) and characteristic response time were found

to be dependent on the applied potential. The former was expected, but the latter is a unique and new result and will inform understanding of the response of cathode catalysts to the conditioning cycles employed in commercial PEM fuel cells. These results are being prepared for publication and will also be presented at the International Society of Electrochemistry's annual meeting in August 2009.

Operation of the PEM fuel cell in full-cell mode was less successful. We experienced two experimental difficulties during this beamtime, which limited the full-cell data that could be obtained. Firstly a fault developed in one of the graphite plates, which we were able to work around, but this meant that we were not able to fully humidify both sides of the membrane electrode assembly (MEA). This causes increased resistance in the MEA and limits the current densities (loads) which can be obtained. The second, and more important problem, was that pin-holes were burnt through the membrane (the layer that separates the anode and cathode in the fuel cell MEA) by the X-ray beam following any period of prolonged exposure. Whilst this did not cause concern when operating in half-cell mode, as we simply moved to a new region of the MEA a few microns away from the pin-hole, it posed a serious safety risk if we were to operate in full-cell mode. Thus, full-cell experiments were not conducted for safety reasons. We would like to conduct further experiments and will utilise much thicker membranes in the future.

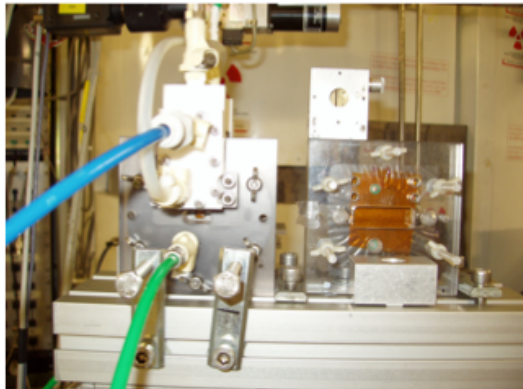


Figure 1. Minature PEM fuel cell on ID24 (left) with I_0 dummy cell (right).

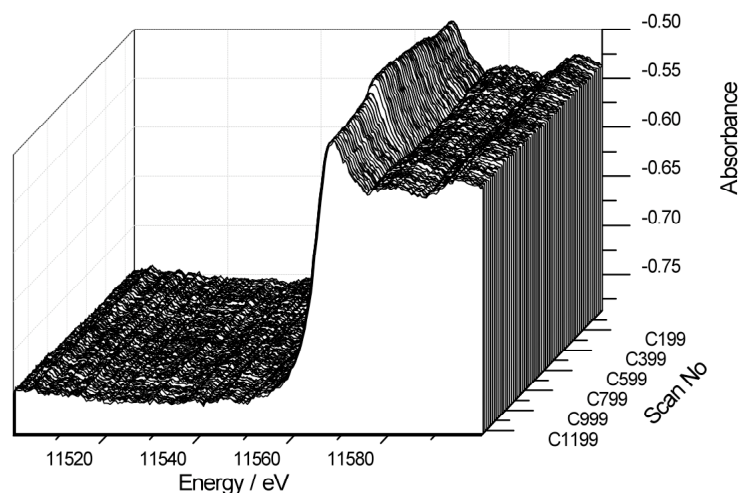


Figure 2. Pt L_3 XANES data obtained in minature PEM fuel cell for a Pt/C cathode, following a potential step from 0.125 to 1.3 V. Cell operated as half-cell.

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